5/21/90

SURFACE MATERIAL REMOVAL ACTION PLAN

FOR

WARNER, NORCROSS & JUDD

ATTORNEYS AT LAW

SITE:

ALBION SHERIDAN TOWNSHIP LANDFILL

ALBION, MICHIGAN

Prepared By:
Great Lakes Environmental Services, Inc.
22077 Mound Road
Warren, MI 48091
phone: (313) 758-0400
fax: (313) 758-1129

WARNER, NORCROSS & JUDD

ATTORNEYS AT LAW

900 OLD KENT BUILDING
111 LYON STREET, N.W.
GRAND RAPIDS, MICHIGAN 49503-2489

TELEX: 226-415 WARCROSS GDR

FAX (616) 459-2170 & (616) 459-2611

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JACK B. COMBS
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JAMES H. BREAY
ROBERT H. SKILTON III
ERNEST M. SHARPE
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J. A. CRAGWALL, JR.
STEPHEN R. KRETSCHMAN
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JON P. BACHELDER
RICHARD A. DURELL
MICHAEL L. ROBINSON
EUGENE E. SMARY
DOUGLAS E. WAGNER
ROBERT W. SIKKEL
THOMAS H. THORNHILL
JEFFREY O. BIRKHOLD
BLAKE W. KRUEGER
JOHN G. CAMERON, JR.
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PAUL T. SORENSEN
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JAMES F. BOSSENBROEK
STEPHEN C. WATERBURY
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ALEX J. DeYONKER
CHARLES E. BURPEE
JOHN D. DUNN
WILLIAM W. HALL
BRUCE C. YOUNG
SHANE B. HANSEN
F. WILLIAM McKEE
LOUIS C. RABAUT
DOUGLAS A. DOZEMAN
JOHN V. BYL
JANET P. KNAUS
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SUE O. CONWAY
STEVEN R. HEACOCK
CAMERON S. DeLONG
WILLIAM J. BARRETT
JEFFREY B. POWER
SCOTT D. HUBBARD
AMY S. KLEMM
MARY LOU HOWARD
STEPHEN B. GROW
M. GAYLE ROBINSON
BRIDGET C. KEHOE
DAVID W. GREEN
TIMOTHY J. McCLAIN
DANIEL R. GRAVELYN
RANDALL S. SCHIPPER
MARK S. BRANSDORFER
ROBERT J. JONKER
DEVIN S. SCHINDLER
AMY L. YOUNG
DAVID L. KACZOR
KENNETH G. RAFTER
DALE E. CARPENTER
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SCOTT H. HOGAN
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CHRISTOPHER C. WILLIAMS
STEVEN P. SCHAD
ROBERT J. BUCHANAN
TIMOTHY P. VERHEY
MICHAEL H. SCHUBERT
VALERIE P. SIMMONS
DUSTIN P. ORDWAY
KENNETH W. VERMEULEN
MARK E. BROUWER
MARK R. LANGE
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JEFFREY A. OTT
DONNA B. STOKES

OF COUNSEL
LAWSON E. BECKER
PHIL R. JOHNSON
CONRAD A. BRADSHAW

DAVID A. WARNER
1883-1966
GEORGE S. NORCROSS
1889-1960
SIEGEL W. JUDD
1895-1982

May 21, 1990

FEDERAL EXPRESS

Ms. Beth A. Henning
Assistant Regional Counsel
United States Environmental
Protection Agency
Region 5
230 S. Dearborn Street
Chicago, Illinois 60604

Re: Albion-Sheridan Township Landfill

Dear Ms. Henning:

In accordance with your telephone conversation earlier today with Kate Lynnes of our office, I am forwarding to Jason El-Zein a preliminary working draft of the work plan required under the Section 106 order issued with respect to the Albion-Sheridan Township Landfill. We understand that the submission of the preliminary draft today will satisfy the time limit set forth in Paragraph 1 of the order. In accordance with your conversation with Kate Lynnes, we will submit a final work plan on or before Tuesday, May 29, 1990. The final work plan will incorporate any changes agreed to at our Wednesday, May 23 meeting and will include the scope of work limitations addressed in previous correspondence.

This letter will confirm that a conference on this matter will be held at 12:00 noon on Wednesday, May 23, at the U.S. EPA office located at 9311 Groh Road, Gross Ile, Michigan. The principal purpose of the meeting will be to discuss the development and implementation of the work plan. We have notified Mr. Thomas Shannon, counsel for Seiler Tank Truck Service, Inc. of the time and place of Wednesday's conference; we would, however, appreciate receiving a confirming letter from you.

Also enclosed is a copy of my letter to Mr. Charles C. McClafferty, an attorney in Jackson, Michigan, who has acted as counsel for Mrs. Gordon Stevick. In my prior conversations with Mr. McClafferty on the subject of Mrs. Stevick's granting access to the Albion-Sheridan site, Mr. McClafferty has unequivocally refused to consider having Mrs. Stevick execute an access agreement. Mr. McClafferty's position is that by virtue of the Stevicks' abandonment of the site in 1981, Mrs. Stevick no longer owns the site and accordingly is unable to grant access to the site. I understand that you have also spoken with Mr. McClafferty and have obtained similar results.

If you have any questions regarding any of the enclosures, or if you wish to discuss this matter, please do not hesitate to give me or Gene Smary a call.

Very truly yours,

Scott D. Hubbard

aan
enclosures

cc: Mr. Marc L. Greenberg
Mr. Paul D. Harper
Mr. Thomas P. Shannon
Mr. Jason El-Zein

INTRODUCTION

An inactive landfill exists at 13355 29 Mile Road, Albion, Michigan. The Albion Sheridan Township Landfill, which was in operation from 1966 to 1981, accepted municipal and industrial wastes. The site currently is not secured, allowing access to the public and wildlife. A variety of surface materials such as demolition debris, storage tanks, empty and full to partially full 55-gallon drums, and some pails ranging from 5 to 15 gallons have been dumped at the site. The U.S. EPA has requested that action be taken to identify these materials and have them properly removed from the site for disposal. Prior to initiating this work, the U.S. EPA has requested that the following documents be submitted for review:

- Overall Project Work Plan
- Site and Health Safety Plan
- Waste Sampling and Analysis Plan
- Laboratory QA/QC
- Transportation and Disposal Plan

The attached materials have been prepared to address the U.S. EPA requirements.

SCOPE OF SERVICES

The overall anticipated scope of services for this project are summarized in Table 1. Great Lakes Environmental Services will be responsible for waste assessment, sample collection, sample screening, and characterizational waste repackaging and waste staging prior to off-site disposal. Additionally, storage tanks when located at site will be cleaned to remove any contamination. Great Lakes Environmental Services will then arrange for transportation and disposal of the material.

Work at the site will be performed under Level B personal protective equipment. A site safety plan for this project is included as Attachment I to this document. Sampling and screening will be performed in accordance with the procedures outlined in the waste sampling plan included as Attachment II to this work plan.

Table 1

ANTICIPATED SCOPE OF WORK

ALBION-SHERIDAN TOWNSHIP SITE

ALBION, MICHIGAN

PART 1: SAMPLE INVENTORY, SCREENING, COLLECTION, ANALYSIS

A. Prepare Overall Work Plan
   1. General Project Scope
   2. Site Health and Safety Plan
   3. Sampling and Analysis Plan
   4. Laboratory QA/QC Plan
   5. Transportation and Disposal Plan

B. Preliminary On-Site Work
   1. Fence Site
   2. Construct Staging Pad
   3. Waste Inventory
      a. number of containers and size
      b. approximate material volume
      c. assess container condition
      d. assess material physical characteristics (gas, liquid, solid)
   4. Collect sample of all wastes

C. Preliminary Off-Site Work
   1. Screen all remaining samples
   2. If feasible, perform material research, e.g MSDS
   3. Combine compatible samples
      a. target disposal sites
      b. minimize analytical work
      c. minimize approval costs
      d. minimize disposal costs
   4. Submit samples for analytical testing
   5. Obtain disposal site approval
      a. complete profile sheets
      b. submit samples for site evaluation
      c. identify primary and secondary disposal sites

PART 2: SAMPLE REPACKAGING, STAGING, ETC.

A. Combine Similar Wastes
B. Repackaging in Oversized or Alternate Containers
C. Label and Mark All Containers
D. Stage Materials for Off-Site Disposal
E. Complete Manifests Prior to Transport

PART 3: WASTE DISPOSAL

A. Transport Off-Site
   1. Load waste hauling vehicle
   2. Placard vehicle as necessary
B. Dispose of Waste Off-Site
C. Waste Disposal certification
   1. Summarize identified waste types and quantities
   2. Summarize disposal results
   3. Make copies of manifests - Generators 2nd Copy
   4. Submit report to U.S. EPA
      a. include above information
      b. include generator certification
      c. include copies of all laboratories results

PART 4: SITE INSPECTION

A. Final summary report

PROJECT IMPLEMENTATION

Great Lakes Environmental Services will dispatch a sampling van, chemist and two trained technicians to the site when given approval to proceed. The van will be equipped with the necessary sampling gear and Level B personal protective equipment. Waste materials will be inventoried and containers will be assessed for structural integrity. Samples will then be collected for analysis. Empty drums will be separated from drums containing materials for proper handling. All drums containing waste and the surrounding surface soil which is visibly stained will be repackaged in 85 gallon over pack drums. Over packed drums will be labeled and staged for later transport.

Great Lakes Environmental Services will transport the samples to Great Lakes' laboratory where the samples will then be screened for additional hazardous characteristics in Great Lakes' laboratory. Based upon these results, compatible waste samples will be composited. The samples and chain of custody document will be submitted to ENSCO for testing in accordance with disposal facility's requirements.

Concurrently, Great Lakes Environmental Services tank clean crew will mobilize to the site to inspect and clean three (3) underground storage tanks. Personnel will be prepared for confined space entry in the event that the tanks cannot be completely cleaned without entry. A Great Lakes Environmental Services confined space entry permit will be completed prior to entering any tank or confined space.

PROJECT IMPLEMENTATION (con't)

Great Lakes will remobilize labor and equipment to the Albion Sheridan Township site for waste consolidation, repackaging and staging. This will include the proper labeling of all wastes. The identified wastes will then be transported via licensed vehicles to the selected disposal facility. Following disposal of all materials off-site, Great Lakes Environmental Services will prepare a waste disposal certification report for submittal to the U.S. EPA. This report will summarize analytical results, volume totals, and a waste disposal summary.

PROJECT COMPLETION

Following off-site waste disposal and prior to completion of the disposal certification report, representatives from Great Lakes Environmental Services and Warner, Norcross & Judd will perform a walk-through tour of the facilities. A major objective of this will be to assure that all identified waste materials have been disposed of and to the satisfaction of the parties involved.

SITE SAFETY PLAN

SITE SAFETY PLAN

FOR:

ALBION - SHERIDAN TOWNSHIP LANDFILL

13355 29 MILE ROAD

ALBION, MICHIGAN

DRUM SAMPLING PROJECT

Prepared by: Andrea Lang

Date: May 18, 1990

GREAT LAKES ENVIRONMENTAL SERVICES, INC.

Site Health and Safety Plan

Outline

A. Project Description

B. Project Number

C. Site Address

D. Project contact Personnel

E. Site Location Map

F. Vicinity Map

G. Work Scope

   1. Project Specifications
   2. General Information

H. Hazardous Materials Description

I. Personal Protective Equipment

J. Site Decontamination Procedures

K. Site Contingency Plan

   1. Emergency Telephone List
   2. Transportation Spill Contingency Plan
   3. Spill Kits

L. Employee Medical Aid

   1. First Aid
   2. CPR
   3. Accident Report Form

M. Hazardous Communication Program

   1. Field Operations Chemical List
   2. Material Safety Data Sheets

SITE SAFETY PLAN

Great Lakes Environmental Services, Inc.
Special Project Group

Before site operations begin all employees and subcontractors involved in these operations will have read and understood this site safety plan and will sign the form at the end of this document.

SITE SAFETY PLAN

Great Lakes Environmental Services, Inc.
Special Projects Group

A. **Project:** Characterization of surface material tank cleaning.

B. **Great Lakes Environmental Services No.**

C. **Location:** Albion Sheridan Township Landfill
13355 29 Mile Road
Albion, Michigan

D. **Contact Personnel**

Warner, Norcross & Judd

Scott Hubbard		(616)459-6121x495

U.S. EPA

Jason El-Zein	On-Scene Coordinator
Beth Henning	Assistant Regional Counsel

Great Lakes Environmental Services

Walt Grabowski Car Phone	Environmental Service Coordinator	(313)758-0400 (517)740-0860
Andrea Lang	Health and Safety	(313)758-0400
John Phelps	Director of Development	(313)758-0400

E. SITE LOCATION MAP

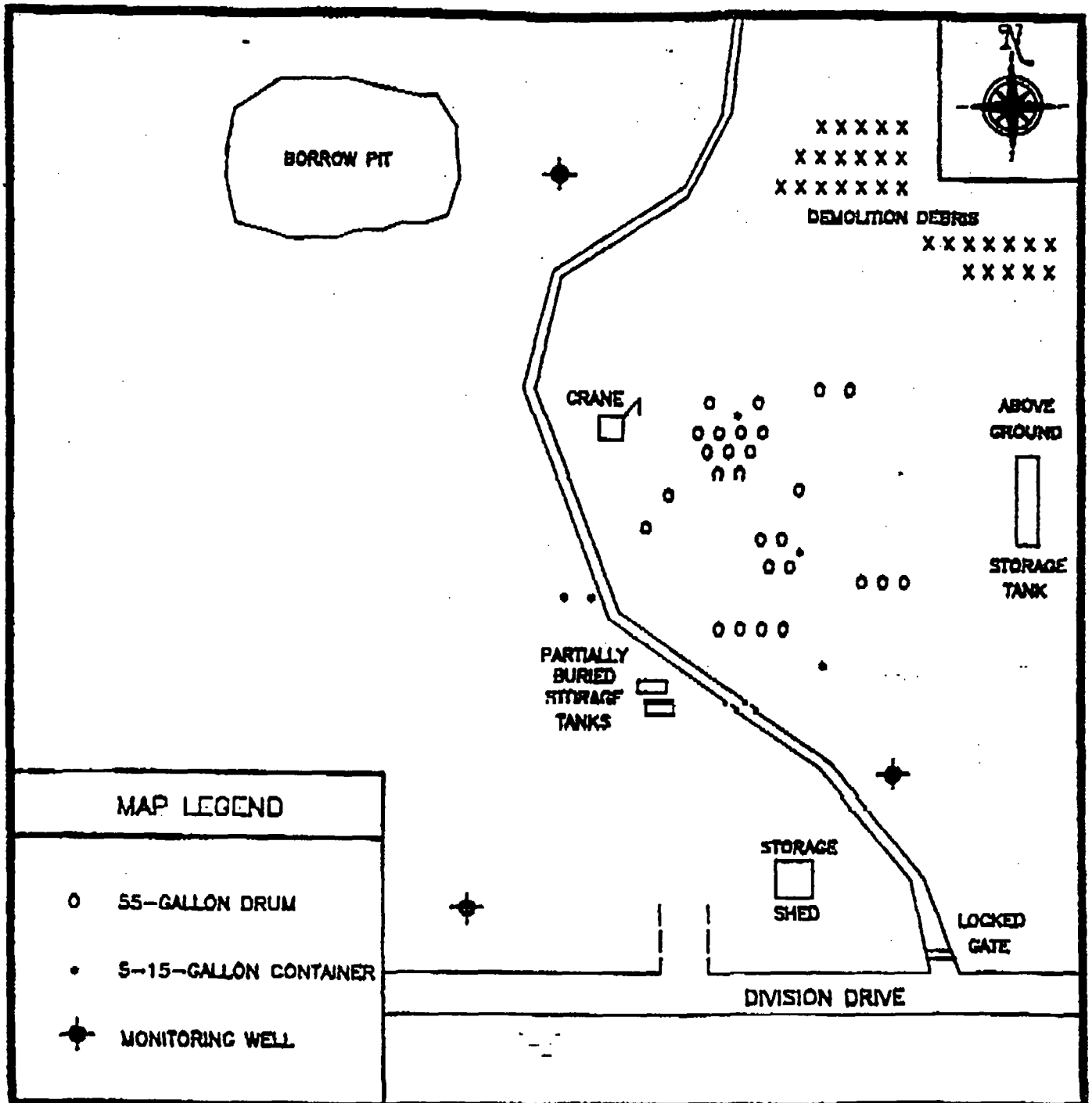


FIGURE 3

SITE MAP

ALBION-SHERIDAN TOWNSHIP LANDFILL

ALBION, MICHIGAN

NOT DRAWN TO SCALE

WESTON

MANAGERS DESIGNERS/CONSULTANTS

DRAWN BY J. BOECKMAN	DATE 11-20-89	PCS # 2428
APPROVED BY J. BINGLEY	DATE 11-20-89	TDD # 5-8910-04

F. VICINITY MAP:

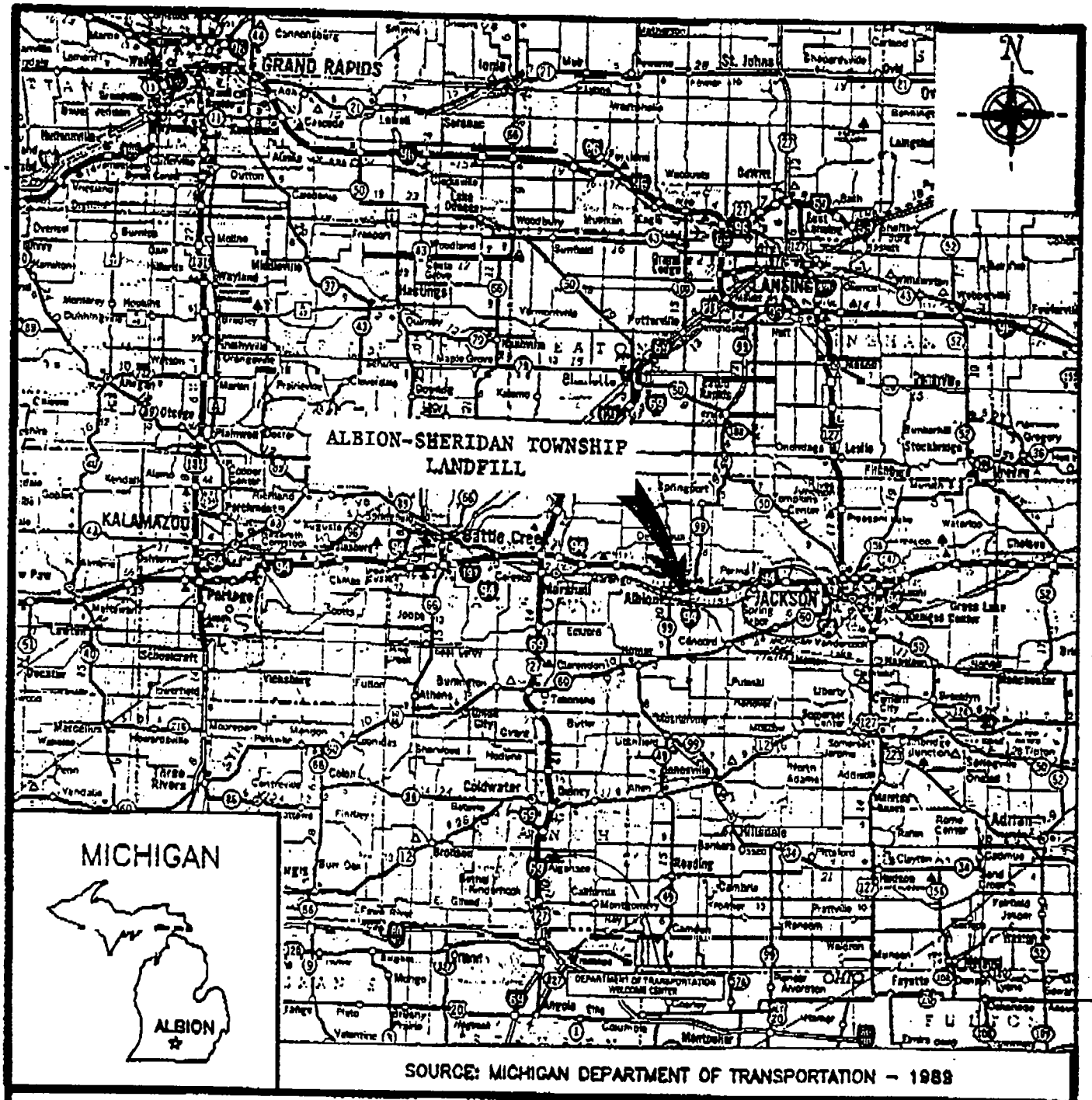


FIGURE 1

SITE LOCATION MAP

ALBION-SHERIDAN TOWNSHIP LANDFILL

ALBION, MICHIGAN

SCALE: 1 INCH = 14.5 MILES

WESTON MANAGERS DESIGNERS/CONSULTANTS

DRAWN BY	DATE	PCS #
J. BOECKMAN	10-23-89	2428
APPROVED BY	DATE	TDD #
J. BINKLEY	10-23-89	5-8910-04

G. WORK SCOPE

1. Project Specification
PHASE I: Sampling

SAMPLING/INVENTORY - Containers will be numbered, and a representative sample will be taken from each. (See Appendix A) Samples will be labeled and numbered to correspond with the containers. All work will be performed under Level B personal protection (SCBA). See Site Safety Plan - Part I.

CONTAINER ASSESSMENT - All containers will be examined for suitability for transport and results recorded.

SAMPLE RESEARCH AND SCREENING -

Hazardous characteristic and compatibility screening at Great Lakes Environmental Services (See Appendix B for procedures)

COMPOSITING OF COMPATIBLE MATERIALS - Samples with comparable characteristics will be composited to reduce the number of waste streams. This technique will minimize cost associated with former analysis and disposal site approval fees. (See Appendix C)

DISPOSAL OPTIONS/LABORATORY ANALYSIS DETERMINATION/WASTE CLASSIFICATION - Using the results of the sample screening and research, Great Lakes Environmental Services will target appropriate disposal methods and sites for each waste stream. Analysis necessary to secure approvals and classify wastes properly will be determined.

G. WORK SCOPE (con't)

Phase II Tank Cleaning

Great Lakes Environmental Services will mobilize personnel and equipment to include a foreman with a pickup and 2 field technicians. A safe, workable area at the site will be designated as the construction zone. Inside this area a "Hot Zone" will be established for protection of all site personnel and will be off limits to unauthorized personnel. The work areas will then be thoroughly inspected to determine the best equipment for the project activities. Personnel will then be briefed on the following work plans:

1. Familiarize personnel with site.
2. Conduct Site Safety meeting using site safety plan
3. Designate a corridor for entering and exiting the "Hot Zone" work area. In this area, all personnel entering the work area will be required to dress in their proper protective level as required and decontaminating as required.
4. Decontaminate the three (3) underground storage tanks. Decontamination will involve the use of a pressure washer and citrikleen. Decontamination fluids will be captured for disposal.
5. If tank entry is necessary to clean tanks, complete a "confined Space Entry Permit" for each tank. A new permit must also be completed after resting breaks, prior to returning tank entry.
6. Secure site.
7. Demobilize crew back to Great Lakes Environmental Services.

H. Hazardous Materials Description

1. Type: Liquid__X__ Solid__X__ Sludge__X__ Vapor/Gas__X__

2. Chemical name/class: Assumed sampling unknown chemicals. List of materials that may potentially be encountered attached.

3. Characteristics: Corrosive__X__ Ignitable__X__ Volatile__X__ Toxic__X__ Reactive__X__.

4. Toxicity: TLV__X__ IDLH__X__

5. Specials hazards: See #2 above, and possible confined space entry;confined space entry permit is attached.

6. Acute expose symptoms: any irritation to eyes, skin or nucous membranes; dizziness or giddiness; nausea; or difficulty in breathing. Symptoms should not be encountered due to the use of 'Level B' protective equipment.

7. Hazard level: High__X__ Moderate____ Low____ Unknown____
   Inhalation__X__ Ingestion__X__ Contact__X__

I. Personal Protective Equipment

1. Entry level of protective clothing:

   A._____ B._X_ C._____ D._____

2. Respiratory protection equipment:

   SCBA___X_____
   Full face respirator_____ Cartridge type_____
   Half face respirator_____ Cartridge type_____
   Dust mask_____

3. Protective Clothing

LEVEL A should be worn when the highest level of respiratory, skin, eye, and mucous membrane protection is needed.

_____ Positive-Pressure (pressure demand), SCBA MSHA/NIOSH approved) REQUIRED

_____ Fully encapsulated chemical resistant suit REQUIRED

_____ Gloves, chemically resistant REQUIRED

_____ Boots, chemical resistant, steel toe and steel shank REQUIRED

_____ Hard hat (under suit)

_____ Coveralls (under suit)

_____ Two-way radio communication

LEVEL B protection should be selected when the highest level of respiratory protection is needed, but a lesser level of skin and eye protection. LEVEL B protection is the minimum level recommended on initial site entry until the hazards have been further identified and defined by monitoring, sampling, and other reliable methods of analysis, in personnel equipment corresponding with those findings utilized.

✓ Positive-Pressure (pressure demand), SCBA (MSHA/NIOSH approved) REQUIRED

✓ Chemical resistant clothing (overalls, jacket coveralls, hooded two piece chemical splash suit, disposable chemical resistant coveralls) REQUIRED

✓ Coveralls (under splash suit)

✓ Boots, outer, chemical resistant, steel toe and shank REQUIRED

✓ Hard hat

_____ Two-way radio communication

LEVEL C protection should be selected when a type of airborne substance is known, concentrations measured, criteria for using air purifying respirators met, and skin and eye exposure is unlikely.

_____ Full face, air purifying respirator (MSHA/NIOSH approved) REQUIRED

_____ Chemical resistant clothing (one piece coverall, hooded two piece chemical splash suit, chemical resistant hood and apron, disposal chemical resistant coveralls) REQUIRED

_____ Boots, chemical resistant, steel toe and shank REQUIRED

_____ Hard hat

_____ Two-way radio communication

_____ Escape mask

LEVEL D is primarily a work uniform. It should not be worn on any site where respiratory or skin hazards exist.

_____ Safety glasses

_____ Work uniform

_____ Hard hat

_____ Steel toe and shank boots

4. Annual Physical Requirements

Great Lakes Environmental Services provides a thorough annual physical to all employees. The physical is designed to meet all governmental requirements relative to our type of work such as Department of Transportation (DOT) driver physicals, OSHA respirator use physical, and EPA clean up contractor medical requirements. The extensive annual physicals helps provide a baseline for the doctors to use in charting each employees state of health over time.

K. Emergency Telephone List

The Project Foreman and each group coordinator will be equipped with an emergency notification device to alert all work crew members in case of any emergency situation.

Emergency notification will be two short blasts with the horn in repeated intervals of five seconds. Upon hearing the emergency notification, the Project Foreman and group coordinator (s) will direct all personnel to a predetermined Safe Zone. The Project Foreman and group coordinator(s) will be responsible for coordinating any necessary first aid procedures and implementing any other required emergency action.

County/Name	Phone Number
Police: Albion	(517) 629-3933
EMS: Albion	(517) 629-9431
Albion Fire Department	(517) 629-3933
Hospital: Albion Community	(517) 629-2191

Directions to Hospital: 29 Mile road west to first cross street and turn left (south), turn right (west) on 28 Mile road. Take 28 Mile road into town (5-6 miles) (road name will change to Eaton Street) follow to Erie, turn right, Albion Community Hospital is 3-4 blocks down on Erie Street.

National Poison Control Center	(502) 432-9516
Chemtrec	1-800-424-9300
Nearest Phone	Supervisor's Pick-Up

K. Emergency Telephone List (con't)

In the event of an accidental or intentional release of a "hazardous substance" in a reportable quantity, the person in charge of the incidental shall notify:

U.S. Coast Guard National Response Center 1-800-424-8802

State Notification:

Michigan DNR Pollution Emergency Alert	1-800-292-4706
Ohio	1-800-282-9378
Indiana	(317) 633-0144
Illinois	(217) 782-7860
Wisconsin	(608) 266-3232

Transportation related hazardous material accidents where:

1. A person is killed or hospitalized; or

2. Property damage exceeds $50,000.00; or

3. A continuing danger exists . . .

. . . The U.S. Department of Transportation (1-202-426-1830) must be contacted in addition to the applicable federal and state numbers.

SITE CONTINGENCY PLAN

GREAT LAKES ENVIRONMENTAL SERVICES, INC.

Transportation Spill Contingency Plan

24-Hour Number (313) 758-0400

In the event of a spill of hazardous waste during transportation, the following actions must be taken and notifications made:

I. Take immediate action to protect human health and the environment.

A. Notify local authorities (police, fire, etc.).

The local authorities can take control of re-routing traffic, crowd control, fire prevention, ambulance, etc. Inform them of any know safety hazards, i.e., flammable, corrosive, etc.

B. Attempt to contain the spill by digging a dike, using sorbents, salvage drums, etc.

IMPORTANT - always consult your manifest and job order safety precautions before approaching a spill or lead. Do not approach the spill if you can not do so in a safe manner for the material involved. Use all of your safety gear. If you cannot approach safely, then dike downstream (direction the material will flow) from the spill direction and block off any pathways to streams, lakes, or storm drains.

II. Notify the home office at our 24 hour number **(313) 758-0400**

During normal office hours, you can call on the toll-free Michigan line 1-800-482-4484 or on the toll-free U.S. line 1-800-428-4482. If you call after hours on the 24-hour line (313) 758-0400, tell the telephone operator that it is any emergency and that you need to speak with your supervisor. Stay on the line while the answering service contacts a manager. When you speak with your supervisor or the responding manager, provide at least the following information:

Your name and location

Telephone number where you can be reached (this could be the local police telephone number)

What was spilled and how much

Any help that you need

Medical
Safety gear
Salvage drums
Additional truck, equipment, or people
Chemical information
Ambulance, tow trucks, etc.

II. Notify the home office at our 24 hour number (313) 758-0400 (con't)

Manifest information

Material description
Generator name and telephone number
Disposal site name and telephone number

Agreed upon a time and method to re-contact each other within the next hour or two.

III. Great Lakes Environmental Services will have to clean up any hazardous waste spill that occurs during transportation or take such action as required by current environmental laws to remove any hazard to human health or the environment. Great Lakes Environmental Services has a firm commitment to reason in a responsible manner in order to protect the public the environment, our customers, and ourselves. In some cases, this could require calling in specialized subcontractors to assist us in a cleanup effort.

IV. Notification Requirements - In addition to handling the immediate problems, several federal and state agencies may require formal notification of any hazardous waste or hazardous materials releases. Failure to make a required notification can result in violations and fines.

A. Federal Notifications

The National Response center 1-800-424-8802 must be notified at the earliest practical moment of any of the following incidents:

1. An incident that occurs during the course of transportation in which as a direct result of hazardous materials or hazardous wastes:

   a. A person is killed
   b. A person received injuries requiring hospitalization
   c. Estimated property damage of $50,00.00
   d. A continuing danger exists in the judgement of the carrier even though a, b, or c do not apply

2. If a hazardous substance is spilled in a reportable quantity (R.Q.) from one package or transport vehicle into or upon the navigable waterways (includes any ditch or creek that connects to a larger river or lake) or adjoining shorelines, the person in charge of the vehicle shall notify the National Response Center at 1-800-424-8802.

B. Federal Information Requirements - Telephone Notifications

If notification is required to be made to the National Response Center due to any spill as described in 1 and 2 above, the following information will be required:

1. Name of the reporter

2. Name and address of carrier

   Great Lakes Environmental Services, Inc.
   22077 Mound Road
   Warren, MI 48091

3. Telephone number where reported can be contacted, i.e.

   (313) 758-0400

4. Date, time, and location of incident

5. The extent of injuries, if any

6. Material description

   a. Name (shipping name or manifest)
   b. Classification (DOT hazard class or manifest, e.g. ORM-E)
   c. Quantity spilled

7. A description of the type of incident (collision, rollover, etc.), nature of the hazardous material involvement (spilled, burned, etc.) and whether a continuing danger to life exists at the scene.

8. If there was a spill for a reportable quantity of a hazardous substance, we must also report the following:

   a. Name of the shipper (generator on the manifest)
   b. Quantity of the hazardous substance discharged, if known

   (NOTE: Hazardous substance and RQs are covered in Section I of this manual)

C. Federal Information Requirements - Written Report

CFR 49, Part 171.16 requires that a carrier who has an incident such as described in A-1 or A-2 involving hazardous material, hazardous wastes, or hazardous substances files a report in writing on DOT Form F5800.1 "Hazardous Materials Incident Report" within 15 days of the incident. A copy of this form is included at the end of this section.

If the incident involved a hazardous waste spill, we must also submit:

1. A photocopy of the hazardous waste manifest

2. An estimate of the quantity of waste removed from the scene, the name and address of the facility to which it was taken, and the manner of disposition of any unremoved waste must be entered in Par H (2 and 3) of the report form. Part H (2 and 3) must also be filled in if there was a spill of a reportable quantity of a hazardous substance.

The completed Hazardous Materials Incident Report must be sent in duplicate to:

Information Systems Manager
Materials Transportation Bureau
Department of Transportation
Washington, DC 20590

D. State Notifications - <u>In addition to Federal</u>

Our hazardous waste transporter permits in some states require us to notify a state environmental agency or emergency response number of <u>spills within their state</u>. In some cases, state have emergency assistance numbers which can provide technical assistance and coordination. When in doubt, it is best to notify the state involved. Great Lakes Environmental Services' main service are covers EPA Region V which includes Michigan, Ohio, Indiana, Illinois, Wisconsin, an Minnesota, so these states head up the list followed by Ontario and then the rest of the states we commonly travel to or through.

Michigan	1-800-292-4706
Ohio	1-800-282-9378 (in Ohio)
Ohio	1-614-224-0946
Indiana	1-317-633-0144
Wisconsin	1-608-266-3232
Minnesota	1-612-296-7373

Ontario — Ontario Provincial Police-Call the Operator and ask for Zenith 50000.

MOE-calling within Ontario 1-800-268-6060
From outside Ontario 1-416-965-9619.

GREAT LAKES ENVIRONMENTAL SERVICES, INC.

Spill Kits

All Great Lakes Environmental Services' drivers are required to carry their standard safety equipment with them when transporting wastes. The drivers' basic equipment includes:

Hard Hat
Safety glasses
Face shield
Half face respirator - with organic vapor/acid gas and dust mist filter cartridges
PVC rain (splash) suit
Steel toe/shank chemical resistant boots
Chemical resistant gloves

Drum transport vehicles are required to carry a spill kit consisting of an 85-gallon salvage (overpack) drum containing:

1 bag floor dry
1 bale of sorbent pads
1 shovel (short handle)
1 broom (short handle)
1 disposable polycoated (yellow) tyvek suit
1 paid disposable boots
1 pair disposable gloves
1 packet of hazardous waste and DOT labels
duct tape
1 large visqueen bag

A standard spill kit for bulk transport vehicles is being designed currently. In the meantime, all bulk vehicles should carry a supply of sorbent pads, a shovel, a bag of floor dry, some duct tape along with the drivers' standard safety equipment.

In the event that a spill kit or material from a spill kit is used on a job, the driver must clearly mark on his service and receipt log the materials used with a notation "FROM SPILL KIT" alongside the material used. This will allow Accounting to keep track of the materials and also notify Operations to replace or replenish the spill kit.

IMPORTANT REMINDER: Whenever approaching any spill, consider your safety first. Can you approach it safely with the materials you have on hand? Take some time to plan your action. Always leave yourself an out! Think, then act!

L. Employee Medical Aid

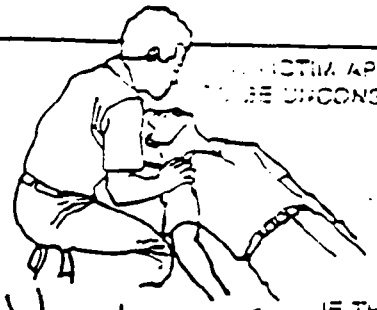
Medical Aid - If you require medical aid while on the job, report the problem to your supervisor immediately. If adequate medical/first aid is not available on the job, you will be sent to the company-appointed medical center as per Article VII of Company Policy.

In an emergency situation, you can seek aid at the nearest emergency medical facility available. Inform your supervisor of the problem as soon as possible. If it is after normal business hours and your supervisor isn't available, you should contact the on-call supervisor **(24 hours a day) at (313) 758-0400.** Likewise, if a co-worker is injured and is not able to make the notification, inform supervision on his behalf. We need to know:

Who was injured
Nature of injury
Name of medical facility rendering aid (phone number, if possible)

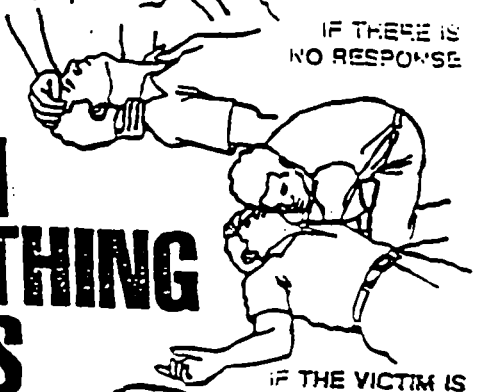
Accident Report - As soon as possible (and always prior to resuming work), see your supervisor and complete an employee accident report form. These forms are used to help identify the cause of the accident and help us to prevent the same type of accident from happening again.

WHEN BREATHING STOPS



IF VICTIM APPEARS UNRESPONSIVE OR UNCONSCIOUS

TAP VICTIM ON THE SHOULDER AND SHOUT, "ARE YOU OKAY?"



IF THERE IS NO RESPONSE

TILT THE VICTIM'S HEAD, CHIN POINTING UP. Place one hand under the victim's neck and gently lift. At the same time, push with the other hand on the victim's forehead. This will move the tongue away from the back of the throat to open the airway.

IMMEDIATELY LOOK, LISTEN, AND FEEL FOR AIR.

While maintaining the backward head tilt position, place your cheek and ear close to the victim's mouth and nose. Look for the chest to rise and fall while you listen and feel for the return of air. Check for about 5 seconds.

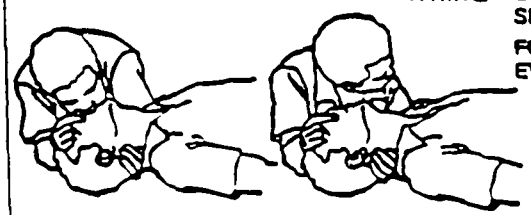
IF THE VICTIM IS NOT BREATHING

GIVE FOUR QUICK BREATHS.

Maintain the backward head tilt, pinch the victim's nose with the hand that is on the victim's forehead to prevent leakage of air, open your mouth wide, take a deep breath, seal your mouth around the victim's mouth, and blow into the victim's mouth with four quick but full breaths just as fast as you can. When blowing, use only enough time between breaths to lift your head slightly for better inhalation. For an infant, give gentle puffs and blow through the mouth *and* nose and do not tilt the head back as far as for *an adult.*

If you do not get an air exchange when you blow, it may help to reposition the head and try again.

AGAIN, LOOK, LISTEN, AND FEEL FOR AIR EXCHANGE.

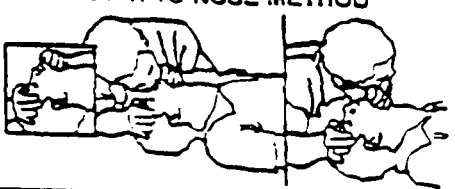


IF THERE IS STILL NO BREATHING

CHANGE RATE TO ONE BREATH EVERY 5 SECONDS FOR AN ADULT.

FOR AN INFANT, GIVE ONE GENTLE PUFF EVERY 3 SECONDS.

MOUTH-TO-NOSE METHOD



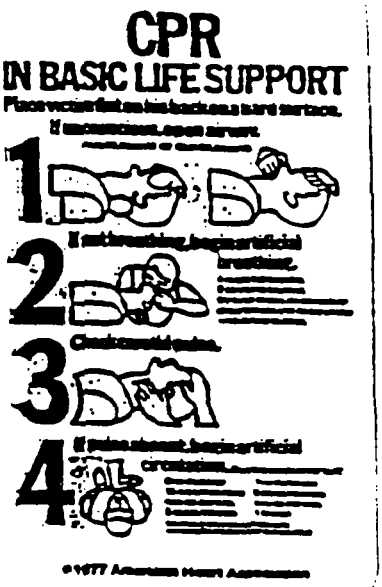
The mouth-to-nose method can be used with the sequence described above instead of the mouth-to-mouth method. Maintain the backward head-tilt position with the hand on the victim's forehead. Remove the hand from under the neck and close the victim's mouth. Blow into the victim's nose. Open the victim's mouth for the look, listen, and feel step.

For more information about these and other life saving techniques, contact your Red Cross chapter for training.

American Red Cross

ARTIFICIAL RESPIRATION

Poster 1002-A
Rev. April 1978
(Oct. 1979 Print)



WE'RE FIGHTING FOR YOUR LIFE

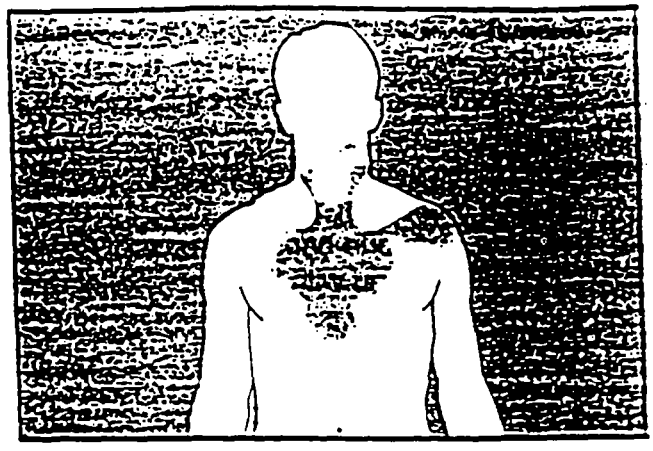
American Heart Association

National Center
7320 Greenville Avenue • Dallas, Texas 75231

Printed by the American Heart Association's Office of Communications
70-023-E
80-83-4MM
5-84-15MM

CPR in Basic Life Support for Cardiac Arrest

American Heart Association



SIGNALS

The most common signal of a heart attack is:

- uncomfortable pressure, squeezing, fullness or pain in the center of the chest behind the breastbone.

Other signals may be:

- sweating
- nausea
- shortness of breath, or
- a feeling of weakness

Sometimes these signals subside and return.

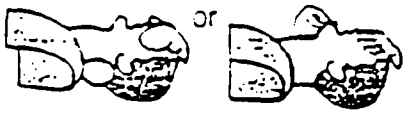
ACTIONS for SURVIVAL

- Recognize the "signals".
- Stop activity and sit or lie down.
- If signals persist 2 minutes or longer, call the emergency number, or if not available, go to the nearest hospital emergency room which provides emergency cardiac care.

There are many causes of sudden death: poisoning, drowning, suffocation, choking, electrocution and smoke inhalation. But the most common cause is heart attack. Everyone should know the usual early signals of heart attack and have an emergency plan of action.

Basic CPR is a simple procedure, as simple as A-B-C, Airway, Breathing and Circulation.

Airway



If you find a collapsed person, determine if the victim is conscious by shaking the shoulder and shouting "Are you all right?" If no response, shout for help. If victim is not lying flat on his back, roll victim over, moving the entire body at one time as a total unit. Then open the airway.

To open the victim's airway, lift up the neck or chin gently with one hand while pushing down on the forehead with the other to tilt head back. Once the airway is open, place your ear close to the victim's mouth:

- Look — at the chest and stomach for movement.
- Listen — for sounds of breathing.
- Feel — for breath on your cheek.

If none of these signs is present, victim is not breathing.

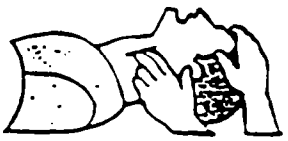
If opening the airway does not cause the victim to begin to breathe spontaneously, you must provide rescue breathing.

Breathing

The best way to provide rescue breathing is by using the mouth-to-mouth technique. Take your hand that is on the victim's forehead and turn it so that you can pinch the victim's nose shut while keeping the heel of the hand in place to maintain head tilt. Your other hand should remain under the victim's neck or chin, lifting up.

Immediately give four quick, full breaths in rapid succession using the mouth-to-mouth method.

Check Pulse



After giving the four quick breaths, locate the victim's carotid pulse to see if the heart is beating. To find the carotid artery, take your hand that is under the victim's neck, or supporting the chin, and locate the voice box. Slide the tips of your index and middle fingers into the groove beside the voice box. Feel for the pulse. Cardiac arrest can be recognized by absent breathing and an absent pulse in the carotid artery in the neck.

If you cannot find the pulse, you must provide artificial circulation in addition to rescue breathing. **Activate The Emergency Medical Services System (EMSS). Send someone to call 911 or your local emergency number.**

External Chest Compression

Artificial circulation is provided by external chest compression. In effect, when you apply rhythmic pressure on the lower half of the victim's breastbone, you are forcing his heart to pump blood. To perform external chest compression properly, kneel at the victim's side near his chest. Locate the notch at the lowest portion of the sternum. Place the heel of one hand on the sternum next to the fingers that located the notch. Place your other hand on top of the one that is in position. Be sure to keep your fingers off the chest wall. You may find it easier to do this if you interlock your fingers.

Bring your shoulders directly over the victim's sternum as you compress downward, keeping your arms straight. Depress the sternum about 1½ to 2 inches for an adult victim. Then relax pressure on the sternum completely. However, do not remove your hands from the victim's sternum, but do allow the chest to return

to its normal position between compressions. Relaxation and compression should be of equal duration.

If you are the only rescuer, you must provide both rescue breathing and external chest compression. The proper ratio is 15 chest compressions to 2 quick breaths. You must compress at the rate of 80 times per minute when you are working alone since you will stop compressions when you take time to breathe.

When there is another rescuer to help you, position yourselves on opposite sides of the victim if possible. One of you should be responsible for interposing a breath during the relaxation after each fifth compression. The other rescuer, who compresses the chest, should use a rate of 60 compressions per minute.

RESCUERS	RATIO OF COMPRESSIONS TO BREATHS	RATE OF COMPRESSIONS
ONE	15:2	80 times/min.
TWO	5:1	60 times/min.

For Infants (Birth to 1 year) and Children (1 year to 8 years)

Basic life support for infants and children is similar to that for adults. A few important differences to remember are given below.

Airway

Be careful when handling an infant that you do not exaggerate the backward position of the head tilt. An infant's neck is so pliable that forceful backward tilting might block breathing passages instead of opening them.

Breathing

Don't try to pinch off the nose. Cover both the mouth and nose of an infant who is not breathing. Use small breaths with less volume to inflate the lungs. Give one small breath every three seconds. If the victim is a child, cover the mouth and breathe every four seconds.

Check Pulse

In an infant, the absence of a pulse may be more easily determined by feeling on the inside of the upper arm midway between the elbow and the shoulder. The pulse check in the child is the same as the adult.

Circulation

The technique for external chest compression is different for infants and small children. In both cases, only one hand is used for compression. The other hand may be slipped under the infant to provide a firm support for his back.

For infants, use only the tips of the index and middle fingers to compress the chest at mid-sternum. Depress the sternum between ½ to 1 inch at a rate of 100 times a minute.

For children, use only the heel of one hand to compress the chest. Depress the sternum between 1 and 1½ inches, depending upon the size of the child. The rate should be 80 times per minute.

In the case of both infants and children, breaths should be administered during the relaxation after every fifth chest compression.

	Part of Hand	Hand Position	Depress Sternum	Rate of Compression
INFANTS	tips of index and middle fingers	mid-sternum	½ to 1 inch	100 per minute.
CHILDREN	heel of hand	mid-sternum	1 to 1½ inches	80 per minute

Neck Injury

If you suspect the victim has suffered a neck injury, you must not open the airway in the usual manner. If the victim is injured in a diving or automobile accident, you should consider the possibility of such a neck injury. In these cases, the airway should be opened by using a modified jaw thrust, keeping the victim's head in a fixed, neutral position.

Other conditions which may cause unconsciousness and airway obstruction include: stroke, epilepsy, head injury, alcoholic intoxication, drug overdose, diabetes.

REMEMBER

1. Is the victim unconscious?
2. If so, shout for help, open the airway, and check for breathing.
3. If no breathing, give 4 quick breaths.
4. Check carotid pulse.
5. Activate the EMSS: Send someone to call "911" or your local emergency number.
6. If no pulse, begin external chest compression by depressing lower half of the sternum 1½ to 2 inches.
7. Continue uninterrupted CPR until advanced life support is available.

CPR for ONE RESCUER: 15:2 compressions to breaths at a rate of 80 compressions a minute (4 cycles per minute)

CPR for TWO RESCUERS: 5:1 compressions to breaths at a rate of 60 compressions a minute

Periodic practice in CPR is essential to insure a satisfactory level of proficiency. A life may depend upon how well you have remembered the proper steps of CPR and how to apply them. You should be sure to have tested both your skill and knowledge of CPR at least once a year. It could mean someone's life.

Emergency Medical Service Telephone Numbers:

Home: _____

Work: _____

Emergency Medical Services System (EMSS)

Any victim on whom you begin resuscitation must be considered to need advanced life support. He or she will have the best chance of surviving if your community has a total emergency medical services system. This includes an efficient communications alert system, such as 911, with public awareness of how or where to call; well trained rescue personnel who can respond rapidly; vehicles that are properly equipped; an emergency facility that is open 24 hours a day to provide advanced life support; and an intensive care section in the hospital for the victims. You should work with all interested agencies to achieve such a system.

Choking

The urgency of choking, its prevention and first aid steps for infants, children and adults cannot be over-emphasized. For more information contact your Heart Association.

For a Healthier Heart

- Have your blood pressure checked regularly.
- Don't smoke cigarettes.
- Eat foods low in saturated (animal) fats and cholesterol.
- Maintain proper weight.
- Exercise regularly.
- Have regular medical check-ups.

Prepared by the
Committee on Emergency Cardiac Care.

IF YOU CANNOT GET IMMEDIATE HELP, THE FOLLOWING SAFETY MEASURES MAY PROVIDE EMERGENCY RELIEF.

In All Cases except poisonous bites, the principle is GET THE POISON OUT or OFF or DILUTE it. CALL PROMPTLY FOR EMERGENCY HELP.

Swallowed Poison: Give a glass of water or milk. Then call the poison control center, doctor, or hospital emergency room for further instructions.
- If advised to induce vomiting, administer syrup of Ipecac (available from most drug stores) as directed.
- Get the victim to medical help. Take any vomit material and the poison container with you.

BUT NOT IF
- patient is unconscious or having seizures.
- swallowed poison was a strong corrosive (lye, strong acid, drain cleaner, etc.).
- swallowed poison contains kerosene, gasoline or other petroleum distillates (unless containing a dangerous pesticide or chemical which must be removed).

To Induce Vomiting: Give one tablespoonful (1/2 ounce) of syrup of Ipecac for a child one year of age or older, plus at least one cup of water. *Never substitute carbonated fluids.* If no vomiting occurs in 20 minutes, this dose may be repeated once only. After vomiting has ceased, offer a slurry of activated charcoal (2-4 tablespoonfuls) in a glass of water.
- If Ipecac syrup is available, try to induce vomiting by tickling back of throat with a spoon handle or other blunt object, after giving water.
- *Do not* give salt or mustard to children.
- *Do not* waste time waiting for vomiting, but transport patient promptly to a medical facility. Bring package or container with intact label.

Inhalation Poisoning (Gas, Fumes, Smoke)
- Get into fresh clean air.
- Loosen clothing.
- If not breathing, start artificial respiration promptly. Do not stop until breathing or help arrives.
- Have someone else call for emergency help and transport to a medical facility promptly.

Bites

Snakes: Keep the person calm and quiet.
- Immobilize the bitten extremity and keep it at or below the level of the heart.
- If mild or moderate symptoms (mild swelling and/or pain, general weakness, nausea, shortness of breath) develop, apply a constricting band, not a tourniquet and not tight enough to cut off circulation. Fashion with any available clothing or tie. You should be able to slip a finger under the band.
- (NOTE: Suction will not be of much value unless incisions are made over the bite marks. Such incisions are *not* recommended unless medical help is not available for several hours or severe symptoms develop.)

Insects: Do not let victim walk, keep as quiet as possible.
- Place any available cold substance on bite area to relieve pain.
- A paste of Adolph's Meat Tenderizer or Baking Soda and water applied to the bite will often reduce the swelling and itching by its enzymatic action.
- If victim stops breathing, use artificial respiration.
- Call for emergency help and transport to a medical facility. (Persons with known unusual reactions to insects stings should carry emergency treatment kits and an emergency identity card).

Human: Wash thoroughly with soap and water.
- Call physician for a severe bite.

Bleeding (Severe): Call for emergency help and transport to a medical facility.
- *Do not* use any antiseptics or other materials.
- Place a thick pad of clean cloth or bandage directly over wound and press firmly to control blood flow.
- Hold in place with strong bandage, necktie, cloth strips, or hand.
- *Do not* make the tie so tight as to prevent circulation to the rest of the limb.
- In case of injuries to the groin, armpit, or neck, where ties cannot be used, control blood flow with fingers or hand pressure.
- Raise the bleeding part higher than the rest of the body, *unless*, bones are broken.
- If injury is extensive, treat for shock.

Nose bleeds: Put the person in a sitting position, leaning forward.
- With a finger against the bleeding nostril, apply firm pressure for five minutes.
- Apply cold compresses to face and nose.
- If bleeding continues, get medical help.

Broken Bones: If a fracture of any part of the body or any injury to the head, neck or back is suspected, the *patient should not be moved* without medical supervision unless absolutely necessary.
- If a patient with a back or neck injury must be moved, keep the back, head and neck in a straight line, preventing them from being twisted or bent during movement. Use a board to help keep back, neck and head rigid.
- For other fractures, until you get medical help, place the injured part in as natural a position as possible without causing discomfort to the patient.
- Protect from further injury by applying splints long enough to extend well beyond the joints above and below the fracture. Any firm material can be used (board, pole, metal rod, or even a thick magazine or thick folded newspaper). Pad splints with clothing or other soft material to prevent skin injury. Fasten with bandage or cloth at the break and beyond joints above and below it. Use pressure bandage to control bleeding. (See Bleeding).

Burns and Scalds: Minor burns may be immersed in cold water. Severe burns should be covered with dry, clean material to exclude air.
- Get medical attention.
- If he is conscious and can swallow, give plenty of water or other *non-alcoholic liquids* to drink.
- *Do not* use ointments, greases, powder, etc.
- Until you get medical help, immerse burned area immediately in cold water or apply clean, cold, moist towels.
- Chill water with ice, if possible, but never add salt.
- Maintain treatment as long as pain or burning exists. In case of chemical burns, flush skin with plenty of running water.
- Cover burned area with clean cloth to exclude air.
- Avoid breaking any blisters that may appear.

If burns are extensive, keep patient quiet and treat for shock.

Choking: If the victim is conscious and cannot cough, speak, or breathe — give four back blows (between the shoulder blades), followed by four abdominal thrusts for adults, four chest thrusts for infants and children.
- For infants, the chest thrusts are delivered with two fingers over the breastbone between the nipples. The baby's head should be lower than the chest for back blows and thrusts. For the child, chest thrusts are given with the heel of one hand over the breastbone (the child should be lying down).

Convulsions: If caused by fever, sponge body with cool water.
- Apply cold cloths to head.
- Lay on side with hips elevated.
- Prevent biting of tongue by using rolled-up handkerchief.
- Be sure tongue is not blocking passage of air to the lung.
- Call physician.

Eye Contamination: Remove contact lenses if worn; *never* permit the eye to be rubbed.
- Flush the affected eye from the inside corner for at least five minutes.
- Call for emergency help and transport to a medical facility promptly.

Fainting: Keep in flat position.
- Elevate legs and feet.
- Loosen clothing around neck.
- Keep patient warm—if necessary.
- Keep mouth clear.
- Give nothing to swallow.
- If breathing has stopped, start Artificial Respiration (see below).
- Have someone call for emergency help and transport to a medical facility if fainting is prolonged.

Shock: Shock usually accompanies severe injury or emotional upset. The signs are cold and clammy skin, pale face, chills, frequent nausea or vomiting, shallow breathing.
- Call for emergency help and treatment.
- Keep the person lying down.
- May elevate the feet if the face is pale and there are no head or chest injuries.
- If the face is flushed or there are head and/or chest injuries, raise the head *and* shoulders.

Artificial Respiration: There is need for help in breathing when breathing movements stop or lips, tongue and fingernails become blue. *When in doubt, apply artificial respiration* until you get medical help. No harm can result from its use, and delay may cost the patient his life. Start immediately. Seconds count.
- Lift the neck gently, tilt head back. Put your cheek and ear close to the victim's mouth and nose; look, listen, and feel for breathing.
- If no breathing, place your mouth over the victim's mouth, pinch the nostrils, and give four quick, full breaths.
- Check again for breathing, and check for a pulse (on the side of the neck).
- If there is a pulse but no breathing, give one breath every five seconds for adults. Remove your mouth between breaths so the victim can exhale.
- If there is no pulse and no breathing, give CPR (cardiopulmonary resuscitation) if trained to do so. Send someone for help as soon as possible.

For Infants: Give one puff of air every 3 seconds.

In Case of Serious Injury or Illness:

Call your emergency medical services (rescue squad or ambulance), doctor, or hospital service immediately. Keep calm, briefly explain what has happened and ask what to do until help arrives.

Our thanks to Dr. Jay M. Arena, Professor of Pediatrics at Duke University Medical Center, for permission to reproduce this first aid chart for parents. Basic first aid principles are to be used in an emergency until professional help can be obtained or consulted.

EMERGENCY TELEPHONE NUMBERS

Doctor _____
Poison Control Center _____
Ambulance/Rescue Squad _____
Hospital _____
Police _____
Fire Dept. _____
Pharmacist _____
Dentist _____
Neighbor _____

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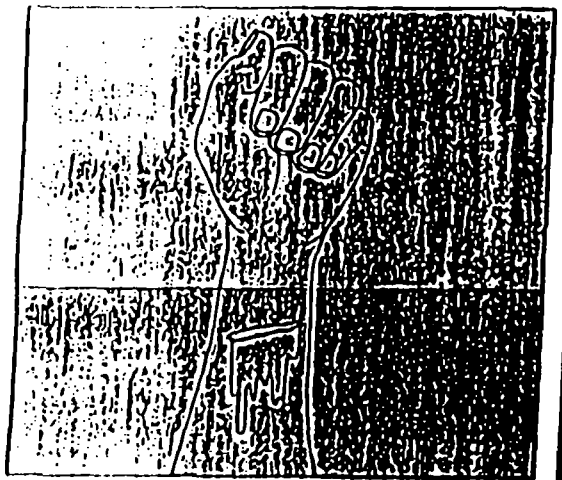
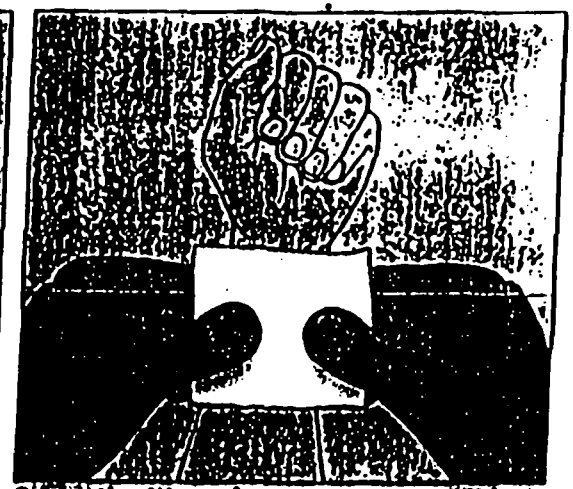
ST. JOSEPH
products of Plough, Inc. Memphis, Tn. 38151

Printed in U.S.A.

HOW TO STOP SEVERE BLEEDING



Spurting or Gushing Blood can cause death in minutes. You can save the life of a bleeding person by acting quickly.



Cover the Wound with a thick, clean compress. If you do not have a handkerchief or piece of clothing, use your hand.

Press Hard and Elevate the wound above the heart. Don't elevate if movement causes pain.

Send for Emergency Help. Send someone else so you can stay with the victim.

What To Do In an Emergency

Help the Victim

1. **Rescue the Victim** from life-threatening danger, if necessary.

2. ***Send Someone*** to seek medical help, if the injury or illness is serious.

3. **Restore or Maintain Breathing** and Heartbeat using mouth-to-mouth resuscitation or CPR.

4. ***Control Heavy Bleeding*** by applying a clean compress and firm, direct pressure to the wound.

5. **Treat Poisoning** as directed by the Poison Control Center. Save any container and try to identify the poison before calling the Center.

6. **Prevent Shock** by helping the victim to lie down and by ***maintaining body temperature.***

7. **Examine the Victim** for other injuries.

8. **Seek Medical Help.** Call 911, if not done previously. ***Arrange follow-up medical care.***

9. **Keep Checking** the victim's breathing and pulse. Don't leave until medical help arrives.

Get Emergency Medical Help Fast

While one person administers first aid or CPR to the victim, another must seek medical help.

Dial 911 or the emergency number for your area. Be ready to answer questions and provide important information:

Location of the Emergency, including cross streets, floor and room numbers, and the phone number from which you are calling.

What Happened? What kind of accident, injury or illness occurred?

How Many People Need Help? Is anyone bleeding or unconscious? What first aid has been administered?

Don't Hang Up First! Be sure you have provided all necessary information.

Training in first aid and CPR can save a life. Learn it BEFORE you need it by contacting your Red Cross chapter.

FIRST AID
[illegible]
YEARS

EMPLOYEE ACCIDENT REPORT FORM

DATE: _____

COMPANY NAME: _____

EMPLOYEE NAME: _____ POSITION: _____

JOB NAME: _____

DATE OF ACCIDENT: _____ TIME OF ACCIDENT: _____

LOCATION WHERE ACCIDENT OCCURRED: _____

_____

_____

WRITE IN YOUR OWN WORDS WHAT HAPPENED? (EQUIPMENT INVOLVED, ETC): _____

_____

_____

DESCRIBE THE NATURE OF YOUR INJURY: _____

_____

_____

_____

DESCRIBE ANY TREATMENT RECEIVED FOR INJURY: _____

_____

WHAT COULD HAVE BEEN DONE TO AVOID THE INJURY OR TO AVOID SIMILAR INJURIES IN THE FUTURE? _____

_____

_____

EMPLOYEE SIGNATURE: _____ DATE: _____

SUPERVISOR TO INTERVIEW EMPLOYEE AND COMPLETE SUPERVISOR REPORT FORM

M. HAZARD COMMUNICATION PROGRGAM

1. Field Operations Chemical List

   a. Citrikleen

2. Material Safety Data Sheet(s) "see next page"

penetone® CORPORATION
A Subsidiary of West Chemical Products, Inc.

74 HUDSON AVENUE, TENAFLY, NJ 07670
EMERGENCY TEL. NO. (201) 567-3000

MATERIAL SAFETY DATA SHEET

(Confidential Formula – Information not to be disclosed to other than recipient and other regulatory agencies.)

DATE March 3, 1989

SECTION I. PRODUCT IDENTIFICATION

TRADE NAME: CITRIKLEEN

FORMULA: Para-menthadiene, alkyl aryl sulfonate, diethylene glycol monobutyl ether, alkyl aryl polyether, ethanolmine, EDTA-type chelate, butylated hydroxytolyene, water.

CHEMICAL FAMILY: Liquid Cleaner

SECTION II. HAZARDOUS INGREDIENTS

	COMPONENT OR MATERIAL CHEMICAL NAMES	CAS NO.	OSHA PEL	ACGIH TLV
*	Ethanolamine	141-43-5	3PPM (6 PPM STEL)	3 PPM
*	Diethylene Glycol Monobutyl Ether	112-34-5	N/A	N/A
	* Listed SARA Title III			

SECTION III. PHYSICAL DATA

BOILING POINT (°F): Approximately 212	VAPOR PRESSURE, mm H g @ 20°C (68°F): Not Determined
EVAPORATION RATE ~~(ether=1) (BuAc=1)~~ (acetone=1): 0.08	VAPOR DENSITY (AIR=1) @ 60-90°F: Not Determined
SOLUBILITY IN H_2O, % by wt @ 20°C (68°F): Forms stable emulsion	% VOLATILES by VOL. @ 70°F: ~70
SPECIFIC GRAVITY H_2O = 1 @ 75°F: 0.976	pH (10% Solution): 10.0

APPEARANCE & ODOR: Clear, light-yellow liquid; citrus-pine odor.

SECTION IV. FIRE AND EXPLOSION DATA

FLASH POINT (Method Used)	FLAMMABLE EXPLOSIVE LIMITS	UPPER	LOWER
165°F (COC); 125°F (PMCC)	Not	Determined	Not Determined

EXTINGUISHING MEDIA: CO2, dry powder, foam type

SPECIAL FIRE FIGHTING PROCEDURES: Treat as Class B (Oil Type) fire.

UNUSUAL FIRE & EXPLOSION HAZARDS: None

SECTION V. EMERGENCY AND FIRST AID PROCEDURES

EYES: Immediately flush with water for several minutes. See physician immediately.

SKIN: Flush with water for several minutes. If irritation develops or persists, consult phys

INHALATION: Remove to fresh air. Perform artificial respiration if needed.

INGESTION: Give large amounts of milk

SECTION VI—HEALTH HAZARD DATA

ROUTE(S) OF ENTRY: Eyes	INHALATION X	SKIN X	INGESTION X

HEALTH HAZARDS *(ACUTE AND CHRONIC)* Acute: Corrosive to skin, eyes, mouth, & esophagus on contact.
Inhalation: May cause dizziness & drowsiness & irritation to mucous membrane.
Chronic: Ethanolamine has been linked to liver & kidney damage in animals.

CARCINOGENICITY:	NTP N.A.	IARC MONOGRAPHS N.A.	OSHA REGULATED

SIGNS AND SYMPTOMS OF EXPOSURE
Inhalation - May cause dizziness & drowsiness & irritation to mucous membrane.
Inhalation of high vapor concentrations may cause dizziness & drowsiness.
Skin - Redness or irritation to skin. Eyes - Irritation or stinging sensation.

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE: Cuts and abrasions

EMERGENCY AND FIRST AID PROCEDURES

SEE SECTION V

SECTION VII. REACTIVITY DATA

CONDITIONS CONTRIBUTING TO INSTABILITY	Product is stable
INCOMPATIBILITY	Strong acids.
HAZARDOUS DECOMPOSITION PRODUCTS	None known
CONDITIONS CONTRIBUTING TO POLYMERIZATION	Will not occur

SECTION VIII. SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED	Collect on absorbent material or mop up with water.
NEUTRALIZING CHEMICALS	Not Applicable
WASTE DISPOSAL METHOD	Allow used emulsions to separate, skim off top oil layer and discharge bottom layer in accordance with EPA regulations

SECTION IX. VENTILATION AND PERSONAL PROTECTIVE EQUIPMENT

VENTILATION REQUIREMENTS		Local exhaust recommended in confined areas.
SPECIAL PERSONAL PROTECTIVE EQUIPMENT	RESPIRATORY	Maintain adequate ventilation.
	EYE	Splash proof goggles, if splashing is anticipated.
	GLOVES	Solvent resistant (rubber/neoprene)
	OTHER CLOTHING & EQUIPMENT	Use goggles, apron, boots, as required .

SECTION X. SPECIAL PRECAUTIONS INCLUDING STORAGE

PRECAUTIONS TO BE TAKEN IN HANDLING & STORAGE (Always refer to label directions when using.)
Do not re-use container. Dispose of container in accordance with local, state and federal EPA regulations.

D.O.T. SHIPPING CLASSIFICATION
Alkaline Corrosive Liquid, N.O.S. (NA 1719)

GREAT LAKES ENVIRONMENTAL SERVICES, INC.

HAZARD COMMUNICATION PROGRAM

General

The following written hazard communication program (as required by Michigan Public Act 154) has been established for:

Great Lakes Environmental Services, Inc.
22077 Mound Road
Warren, MI 48091

The program is available in the office library for review by all employees.

I. Hazard Determination

a. Great Lakes Environmental Services will rely on Material Safety Data Sheets (MSDS's) from material suppliers to meet hazard determination results requirements.

II. Labeling

a. The Operations Department shift foreman will be responsible for seeing that all incoming containers of supplies ar properly labeled.

b. All incoming containers of supplies must be labeled for: Identity, hazard warning, and name and address of manufacturer

c. Portable containers into which hazardous chemicals are transferred from labeled containers do not have to be labeled only if they are for the immediate use of the employee who performs the transfer. Other portable containers (e.g. 5 gallon pails, etc.) of materials filled from labeled hazardous chemical containers for use by others must be labeled in the same manner as the original container.

d. Piping systems shall by tagged in each area of the shop for the following "hazardous chemicals" where required:

Compressed air
Natural gas

III. Material Safety Data Sheets (MSDS)

a. The Director of Purchasing will be responsible for compiling the master MSDS file. It will be kept int he Director of Purchasing's office.

b Copies of all MSDS's for all hazardous chemicals which operations, maintenance, and field staff may use or have potential to be exposed to will be kept in a binder in the operations office. These may be reviewed upon request.

c. Copies of all MSDS's for all hazardous chemicals which the technical staff may use for laboratory screening will be kept in a binder in the lab. These may be reviewed upon request.

d. The Director of Purchasing shall require MSDS's for all supplies covered as hazardous or potentially hazardous chemicals. A file of follow-up letters shall be maintained by the Director of Purchasing for all shipments received without an adequate MSDS either on file or accompanying the shipment.

e. The Director of Purchasing shall provide the appropriate departments with the new or revised MSDS's within 5 days of receipt. The Director of Purchasing shall update the MIOSHA "New or Revised MSDS" poster (located on the company notice board) within 5 days of receipt of a new or revised MSDS.

IV. Employee Information and Training

a. A technical Director shall provide training programs and training documentation as required by this standard.

b. Before starting work, each new employee will attend a new employee orientation class (including basic safety). Each new employee will be issued a Great Lakes Environmental Services Employee Safety Manual which has information on:

- Safety
- Accidents and first aid
- Exposure hazards
- Basic chemical hazards
- Physical hazards
- Heat stress
- Personal protective equipment
- Respiratory protection
- DOT/EPA labels and placards
- EPA levels of protection
- Confined spaces
- PCB's
- Personnel and equipment Decontamination
- Hygiene
- Right to know
- Manifesting regulated wastes
- Transportation spill contingency plan

c. Employees will be trained in how to obtain and interpret MSDS information, label interpretation, and the details of this hazard communication program as covered in the "Right To Know" section of the safety manual.

d. When a new hazard is introduced into a work area in the form of a new hazardous chemical supply the employees in the work area must be trained in how to safely work with the new hazard and notified of MSDS availability. In cases of a new supplier providing a replacement material for an existing hazardous chemical with the same hazard a notification of new MSDS availability coupled with proper labeling shall suffice.

V. Hazardous Non-Routine Tasks

a. Use of hazardous chemicals in situations such as confined space entry and hot work requires that special precautions be

followed. Great Lakes Environmental Services Confined Space Entry Permit Program must be followed as per company policy for each and every entry.

VI. Informing Contractors

a. The Director of Purchasing will notify any contractor employees with employees working at the Great Lakes Environmental Services facility of the existence of our Hazard Communication Program. Instruction on how contractor employees may obtain MSDS information on hazardous chemicals that they may be exposed to while performing work at Great Lakes Environmental Services shall be included the notification may be via written notification on the original purchase order, letter, and/or via contractor orientation on site prior to work performance.

b. Where Great Lakes Environmental Services is acting as the general contractor on a construction project (lagoon closure, major site remediation, etc.), the Project Manager shall maintain a binder with Material Safety Data Sheets for each hazardous chemical used at the project site. The MSDS binder shall be kept in the site trailer and shall be made available to interested employees and subcontractors upon request. The existence and location of the MSDS binder shall be covered in site safety briefings and site orientation to employees and subcontractors.

VIII. List of Hazardous Chemicals

The following is a list of Hazardous Chemicals used at Great Lakes Environmental Services. Further information on each hazardous chemical noted can be obtained by reviewing Material Safety Data Sheets (MSDS') in the designated areas as per section III and VI of this program i.e.

Operations Office - maintenance and field staff

Lab - Laboratory screening staff

Site trailer - All staff on field projects where Great Lakes Environmental Services is the general contractor.

Additions will be made to this list as new materials are added and/or new hazard information becomes available. Deletions from the list will also occur in the event that a hazardous chemical supply is exhausted and no longer used.

Great Lakes Environmental Services, Inc.

EMPLOYEE PROJECT AWARENESS

Employees involved in this job have been advised of the contents of this plan an the potential health hazards both physical and chemical.

Great Lakes Environmental Project Supervisor (print)	Project Supervisor (Signature)
Great Lakes Environmental Employee (print)	Employee (signature)

cc: Andrea Lang - GLES

APPENDIX A

SAMPLING EQUIPMENT AND PROCEDURE LISTING

Sampling a Drum

Drums containing liquid wastes can be under pressure or vacuum. A bulging drum usually indicates that it is under high pressure and should not be sampled until the pressure can be safely relieved. A heavily corroded or rusted drum can readily rupture and spill its contents when disturbed; it should only be sampled with extreme caution. Opening the bung of drum can produce a spark that might detonate an explosive gas mixture in the drum. This situation is difficult to predict and must be taken into consideration every time a drum is opened. The need for full protective sampling equipment cannot be overemphasized when sampling a drum.

1. Position the drum so that the bung is up (drums with the bung on the end should be positioned upright; drums with bungs on the side should be laid on its side, with the bungs up).

2. Allow the contents of the drum to settle.

3. Slowly loosen the bung with a wrench, allowing any gas pressure to release.

4. Remove the bung and collect a sample through the bung hole with a thief sampler.

5. When there is more than one drum of waste at a site, segregate and sample the drums according to waste types.

APPENDIX B

SAMPLE SCREENING PROCEDURES

SAMPLE SCREENING PROCEDURES

FLAMMABILITY

1. Place approximately 5-10 ml of representative sample into a disposable beaker. Pass an open flame across the top, if the fumes flash or ignite that material has a flashpoint equal to the ambient room temperature.

2. By using a glass or metal container and either heating or cooling the sample and measuring the temperature prior to introducing an open flame an approximate flash range could be established.

   eg. A sample with a flashpoint of 115 can be heated to approximately 125 measuring the temperature with a thermometer, getting a flash at that temperature. The sample will cool measuring the temperature until it reached approximately 110 at which point it won't flash. The flashpoint would be somewhere between 110 and 125 so a quick categorization as combustible can be made.

3. If the sample doesn't flash at room temperature a flame can be touched directly to the material, if the flame flares the material probably is combustible or has a flashpoint between 90 and 140 .

4. If a sample doesn't flash at room temperature or flare on contact with a direct flame the material probably has a flashpoint >140 .

pH

1. For agqueous solutions pH paper is very reliable and easy to use in obtaining a rough estimate of pH.

2. For very dark colored material the color of the sample may block out or disrupt the coloring code of the paper. The material may be diluted with water to lighten the sample in order to get a readable color change from the paper. The pH might be as accurate but a readable pH reaction will allow a general characterization as basic or acidic.

3. pH paper has a very limited value in testing organic material. Usually the organic sample will either transfer its own color to the paper or wet the paper leaving the color of the paper itself as a reading. A pH meter of some kind would give a better reading.

4. Strength of an acid is very important in determining appropriate disposal options. A general test to determine whether landfill or neutralization is the best option is the use of 50% caustic test. A 5-10 ml sample is placed behind some protective shield, a 50% solution of sodium hydroxide is then slowly added. Any smoking, splattering, or bubbling

should be notes as well as a temperature rise that goes much above 150 . This is the exact test used by disposal sites and if any of the above reactions occur the acid probably won't be accepted for landfill.

ORGANIC

1. Fill a clear container with water, the sample should be added slowly watching to see if the material sinks, floats, or mixes freely with the water. Generally if the material maintains its integrity and sinks or floats the material is organic.

2. Specific gravity can also be estimated form the above procedure. If the material floats it will have some specific gravity below 1. If it sinks the specific gravity probably is greater than 1.

3. The white sorbants we use repel water and readily soak up organic material. Slowly put a small volume of sample onto a sorbant pad, if the material is soaked up it is organic. If the material beads or puddles without soaking in it is probably aqueous. Material that has an organic that might be soluble in water or a mix of some sort usually soaks in but not as quick or complete.

CHLORINATED

1. A sample of the material (liquid) can be added to water. If the material sinks to the bottom there is a good chance its chlorinated.

2. Pass an open flame over the top of a sample. If the smoke becomes dark black, if the flame flutters and goes out as you lower it towards the sample, or if the bottom of the flame gets a green shade a chlorinated solvent is probably present.

3. Using a stirring rod pass a sample through or around the edge of a flame, if a green flame occurs chlorine is present. A disposable pipet should be filled with sample then emptied. Next squeeze the pipet gently blowing fumes from the material through and around an open flame. Once again, a green color signifies chlorination.

SULFIDES

1. If a material has a very high sulfide concentration usually odor will be a key indicator with a rotten egg or swampy smell.

2. Lead acetate test strips can also be used to test for the presence of sulfides. A 5-10 ml sample should be mixed very carefully with an equal amount of 4:1 solution of hydrochloric acid. A white lead acetate test strip is suspended over but

not touching the sample and some type of lid is placed on top to keep the hydrogen sulfide gas inside. If the test strip turned brown after a 1-5 minute time period there are sulfides present. Speed and degree of color change is an indication of concentration but further analytical results may be required.

PEROXIDE

1. Test strips for peroxides are used on samples of ethers and other known peroxide formers in order to ensure safety and a lack of peroxide crystals. The test strip is dipped into the sample then air-dried for 1 minute. (Breathing on the moistened strip is suggested) A color key on the test strip container codes for varying concentrations of peroxide crystals.

2. Sodium metabisulfite dissolved in water can be used to neutralize peroxide crystals. Copper may then be added to keep peroxides from reforming.

ISOCYANATES

1. Picking our isocyanates is generally quite simple as they react in a unique manner. A small sample of material can be mixed with about half as much ammonium hydroxide or ethylene diamine. Generally a change of color, production of heat, or bubbling and foaming signifies the presence of any iso.

2. Even if the isocyanate is contaminated with another material or only makes up part of your sample this test usually will pick the iso out. The iso in the sample will react to so a thickening or forming of solid will occur but foremost the production of heat. If no reaction occurs there is no iso present or the concentration is so low as to disregard.

CYANIDE SPOT TEST

Reagents:

1. Chloramine - T solution - 1g In 100g or 100 ml water (prepare weekly)

2. Pyridine - barbituric acid reagent - add 6.0g barbituric acid in 100 ml volumetric flask - add just enough water to wet the barbituric - add 30 ml pridine and mix - add 6 ml conc. HCI mix and cool to room temperature - dilute to the mark and mix (prepare monthly).

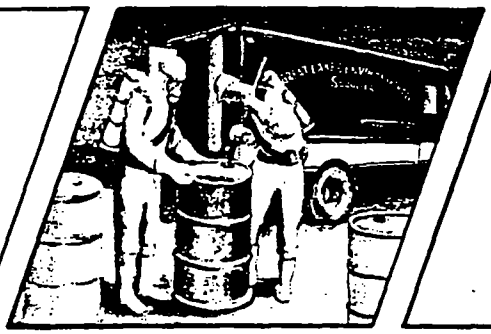
Procedure:

To a test tube add six drops of sample and two drops Chlor-T solution and mix, add two drops pyridine - barbituric solution and mix - after one minute a pink to red color indicates 50 ppm or greater CN*

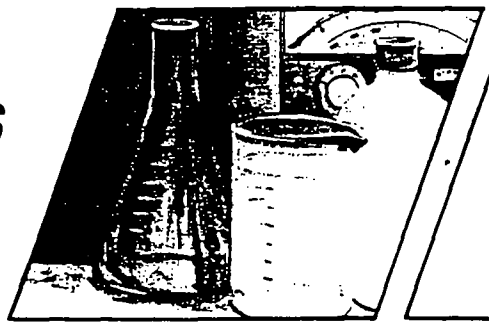
*Reference: U.S. EPA Guidance Manual

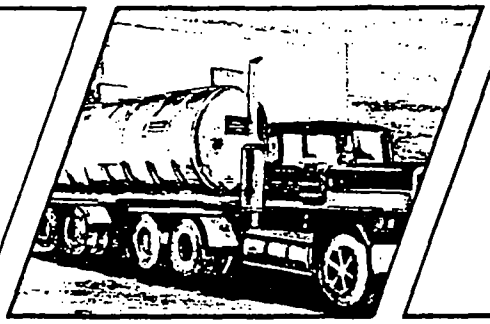
QUALIFICATIONS & EXPERIENCE

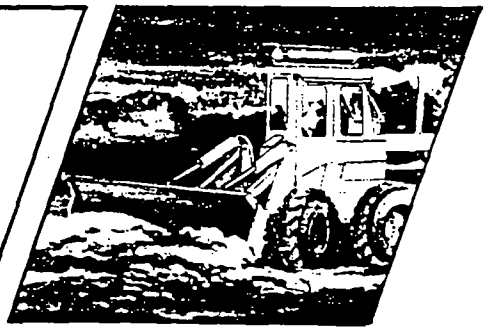
GREAT LAKES ENVIRONMENTAL SERVICES, INC.



qualifications & experience







great lakes environmental services, inc.

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Chicago Office: 5312 W. 124th Street • Alsip, IL 60658 • **(312) 385-4747**
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Indianapolis Office: 8900 Keystone Crossing, Suite 680 • Indianapolis, IN 46240 • **(317) 574-9320**
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contents

qualifications & experience

Great Lakes Environmental Services, Inc. is an independent, management/investor-owned company, providing full services in the management of industrial and hazardous waste, remedial action programs and site decontamination. Great Lakes Environmental, with 13 years of experience, has earned its reputation by being responsive to the specific needs of each customer and by using the latest equipment and a well-trained, experienced staff.

In response to the increasing environmental compliance needs of industry, Great Lakes Environmental has diversified and expanded its technical capabilities over the past decade. Because of its diversified approach and because it is not tied to any one reclamation process or disposal method, Great Lakes Environmental can provide vigorous attention to each customer's specific needs, using its full resources and extensive experience to provide the most environmentally sound and cost-effective solutions.

Great Lakes Environmental began in 1953 as Stock Brothers Corporation. In the company's early years its principal services focused on underground construction contracting. In 1971 the company expanded its services to include industrial maintenance contracting through a subsidiary of the Stock Brothers Corporation. Then in 1976 Stock Brothers Corporation developed a division that specialized in hazardous waste transportation and emergency spill response--Great Lakes Environmental Services Division. Over the next ten years as the company experienced rapid growth in the area of regulated waste management, Great Lakes Environmental recognized that affiliation with a national corporation would ensure valuable support and continued growth, and in 1986 became affiliated with Environmental Systems Company (ENSCO) of Little Rock, Arkansas.

Finally, in its need for further financial growth and diversity, coupled with an expanded management focus, Great Lakes Environmental became a management and investor-owned company on December 22, 1988. In addition to ENSCO, Advent International Corporation (Boston), First Analysis Corporation (Chicago) and Sequoia Capital (Menlo Park, California) were added as investor shareholders. Great Lakes Environmental now benefits from direct employee ownership and growth capital provided by investment firms who have provided financing for many major companies, some of which are now of the Fortune 500.

Great Lakes Environmental provides services to customers in all midwestern states through its service centers in Detroit and Chicago and sales offices in Indianapolis, Columbus, and Milwaukee. Customers of Great Lakes Environmental typically include waste generators, potentially responsible parties (PRPs), engineering consultants, other contractors, lawyers, and environmental regulatory agencies.

In today's hazardous waste contracting market, industry has come to expect from contractors a number of important and even critical capabilities. Foremost of these capabilities is a contractor's ability to minimize environmental liability while controlling costs. To do that, Great Lakes Environmental has established both a management structure and a corporate philosophy that emphasize the following basic work tenets: integrity, experience, safety, reliability, availability, flexibility, and accuracy. With this philosophy, Great Lakes Environmental is able to offer hazardous waste services with full regulatory compliance at a competitive fee.

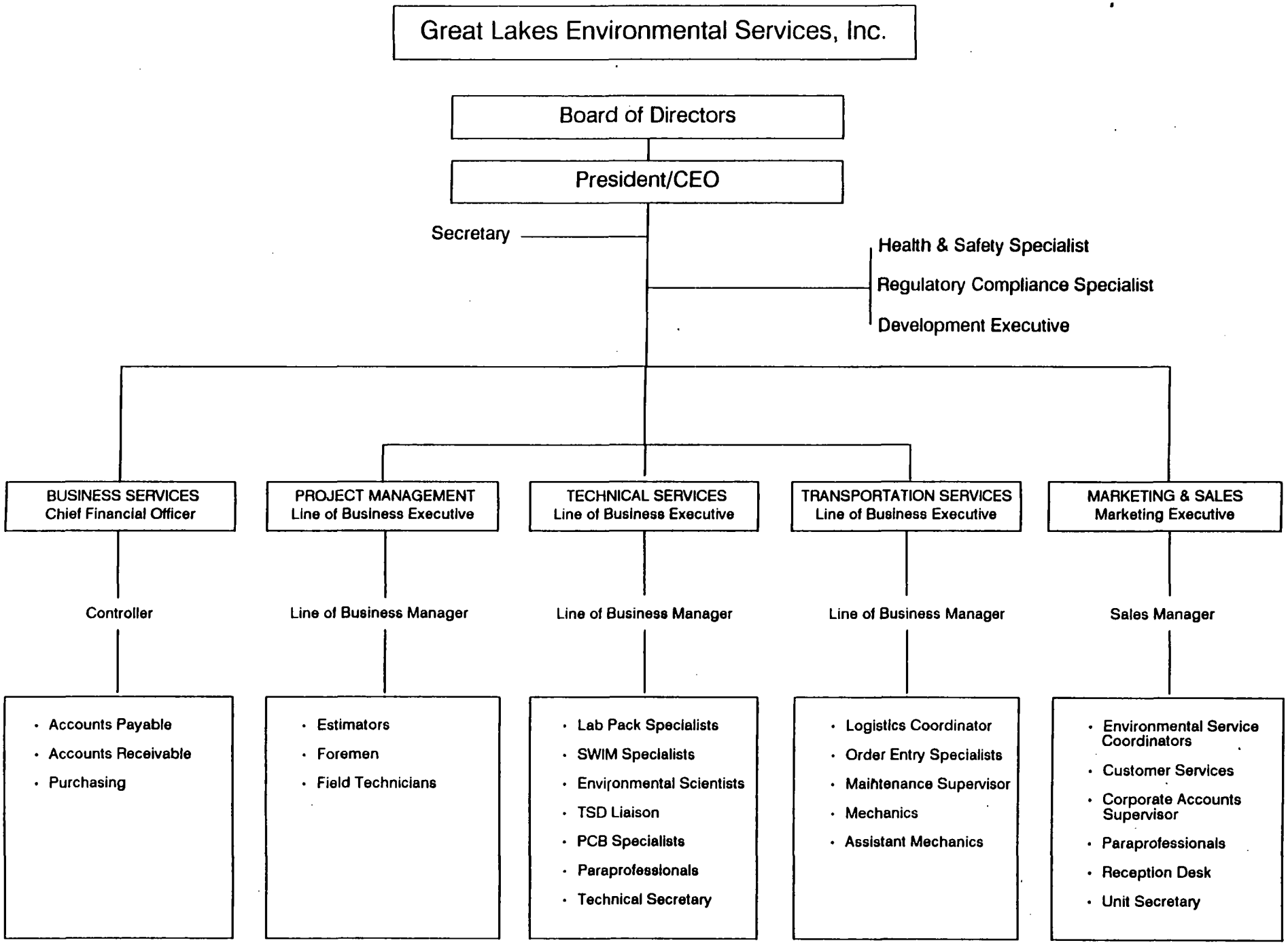
The following overview illustrates Great Lakes Environmental's range of technical capabilities and depth of experience. The overview highlights the qualifications and experience of the main divisions that comprise Great Lakes Environmental - Technical Services and Field Services. The organizational structure of Great Lakes Environmental is shown in Figure 1.

TECHNICAL SERVICES

The Technical Services Group at Great Lakes Environmental is a clearing house and technical resource center. This group provides employee training (including safety training and record-keeping), quality assurance/quality control, complete computer management information and tracking systems, maintenance of qualifications files for reclamation and disposal or treatment alternatives, and a comprehensive chemical dictionary for lab pack services and waste classifications. Environmental Service Coordinators are available to respond to customer questions and needs.

Employee Training: Through regularly scheduled employee training programs, the Technical Services Group keeps staff members up to date on topics such as safety, state and federal environmental regulations, accident prevention, and new technologies in the field. Since safety and training are so important, the Technical Services staff maintains records of every staff member's training course attendance and conducts and evaluates medical monitoring of all field personnel on a regular basis. This focus on staff training and experience helps to assure that the work is done correctly, safely, and efficiently. The employee training programs also prepare the staff for addressing and responding to a wide range of customer needs, including emergency response, confined space entry, appropriate sampling protocol, and proper equipment operation.

Lab Pack Services: The Technical Services Group maintains an extensive and continually expanding computer-based "chemical dictionary", which was developed in-house for characterizing wastes, identifying waste constituents, and identifying material handling and safety requirements and disposal/treatment options. The Technical Services staff utilizes the chemical dictionary in generating "Lab Pack" packing lists to ensure that field chemists and technicians can safely and efficiently package waste laboratory chemicals for secure transport and disposition.


Great Lakes Environmental Services, Inc.
Board of Directors
President/CEO
Secretary
Health & Safety Specialist
Regulatory Compliance Specialist
Development Executive
BUSINESS SERVICES
Chief Financial Officer
PROJECT MANAGEMENT
Line of Business Executive
TECHNICAL SERVICES
Line of Business Executive
TRANSPORTATION SERVICES
Line of Business Executive
MARKETING & SALES
Marketing Executive
Controller
Line of Business Manager
Line of Business Manager
Line of Business Manager
Sales Manager
• Accounts Payable
• Accounts Receivable
• Purchasing
• Estimators
• Foremen
• Field Technicians
• Lab Pack Specialists
• SWIM Specialists
• Environmental Scientists
• TSD Liaison
• PCB Specialists
• Paraprofessionals
• Technical Secretary
• Logistics Coordinator
• Order Entry Specialists
• Maintenance Supervisor
• Mechanics
• Assistant Mechanics
• Environmental Service Coordinators
• Customer Services
• Corporate Accounts Supervisor
• Paraprofessionals
• Reception Desk
• Unit Secretary

Waste Evaluation and Reclaim/Disposal Services: Unknown wastes require additional evaluation to assure appropriate disposal. The contents must be sampled, analyzed, and properly identified before assignment is made to an appropriate facility. While this can be a costly and dangerous task for those not properly trained, Great Lakes Environmental has highly trained technicians to handle the job safely and efficiently. Using a systematic four-step procedure, Great Lakes Environmental:

1. Inventories and numbers all containers;
2. Opens and samples each container using a sampling tube or other appropriate device;
3. Groups containers of similar materials, and composite samples of containers where possible; and
4. Completes laboratory analysis to establish waste characteristics and disposal options.

By following this procedure, Great Lakes Environmental can minimize laboratory fees without compromising safety and disposal considerations. Laboratory services are typically provided by independent third party analytical laboratories. After field samples have been collected, Great Lakes Environmental's computer-based tracking system is used to maintain a sample approval file and to provide instantaneous status updates. As an added service, the Technical Services Group maintains confidential files sorted by customer and location.

Technical Services also maintains extensive information on reclamation, treatment and disposal services available in the midwestern states as well as in other regions. This pre-screening service is intended to identify the full range of options available to customers of Great Lakes Environmental and the reclamation, disposal and treatment companies who truly can minimize environmental liability through technically sound treatment/disposal systems.

Finally, the Technical Services Group continually provides internal quality assurance checks to measure the company's performance, follow through, and responsiveness to the customer's needs.

PCB Services: Polychlorinated biphenyls (PCBs), which were widely used and are very persistent in the environment, are now strictly regulated in their use, handling, and disposal. In response to the growing need for management of PCB's and PCB-contaminated materials and equipment, Great Lakes Environmental provides a broad range of services for the safe and proper disposal of this material.

The wide range of PCB services Great Lakes Environmental can provide its customers include:

- PCB sampling and analysis;
- Packaging, transportation and disposal of PCB-contaminated items such as capacitors and light ballasts;
- Transformer draining, flushing, and disposal of liquids and carcasses through their PCB processing facility as required by the Toxic Substance Control Act (TSCA);
- Emergency spill cleanup and decontamination of PCB leaks; and
- Computerized tracking system from the point of origin to the final disposal location.

Great Lakes Environmental holds all the licenses and permits under federal, state, and local regulations necessary to process and transport PCB's. Vehicle options include enclosed vans, bulk tankers, and rolloff boxes.

Great Lakes Environmental's secured, 30,000-square-foot facility in Warren, Michigan includes an indoor 6,000-square-foot PCB processing and storage area. At this location, PCB wastes including transformers and other PCB-contaminated waste solids and liquids can be handled, bulked into full loads, and shipped safely and economically to final disposal sites. All floors and dikes within the transfer areas exceed EPA requirements for secondary containment. With these facilities, Great Lakes Environmental is able to offer substantial cost savings to customers, particularly for those with small quantities of PCB wastes.

All PCB-related wastes are logged and tracked by Great Lakes Environmental's computer-based tracking system. This provides permanent accurate data base files that can be accessed by customer name, waste type, date, and disposal location. In addition, up-to-date status reports of PCB wastes and sample analyses are available to the customer at all times.

FIELD SERVICES

The Field Services Group handles all waste remediation activities transportation, vessel cleaning, and emergency response. Experienced professionals, fully trained and equipped with the latest in specialized equipment, are available to provide services 24 hours per day, 7 days per week. Each staff member has been trained in safety procedures, accident prevention, confined space entry, personal safety equipment, sampling protocol, emergency response, transportation safety, spill response, and decontamination procedures.

Remediation Services: Great Lakes Environmental has a select group of professionals dedicated to performing field remediation activities. These activities include site remediation and decontamination, and special projects such as site assessments. These services can be handled on a contractual or turnkey basis. Experience with numerous treatment technologies allows the members of the remediation services group to design the most environmentally sound solution using cost-effective management practices. Emphasizing a multidisciplinary approach, this group frequently coordinates specialists in analytical chemistry, hydrogeology, toxicology and environmental engineering to identify the optimum solution for each customer's specific needs.

Some of the site remediation activities and decontamination services that Great Lakes Environmental has managed include the removal of PCB-contaminated equipment and soils, cleanups related to leaking underground tanks, and spill remediation. The remediation services group has also undertaken many projects involving the release of gasoline and other fuels.

Over the past few years, remediation services has focused much of its attention on site assessments and environmental liability investigations related to real estate transactions. The purpose of these assessments is to identify and quantify the type and extent of contamination that may be present on a piece of real estate. In this growing area of concern, an industrial site may undergo one or more phases of investigation to determine if the site presents environmental liability issues. An environmental liability investigation typically involves file searches, exploratory excavations, and drilling programs.

In addition to the services outlined previously, the company has established extensive project experience in the following areas:

- Plant closures
- Lagoon cleaning/closures for active and inactive sites
- Tank closures
- Drum removals
- Exploratory and contaminant excavations
- Packaging chemicals and contaminants for removal
- Manufacturing changeovers

Transportation: Waste transportation services for hazardous and non-hazardous solids and liquids are provided using well maintained and specially designed equipment. Great Lakes Environmental can transport waste either to a generator-specified site or to one arranged for by Great Lakes Environmental and chosen by the generator. A current listing of transportation and support equipment is provided in the appendix. As the summary of transportation and support equipment shows, Great Lakes Environmental has the right equipment for practically every industrial and hazardous waste requirement. All over-the-road tractors, trailers, and support vehicles have current hazardous waste

transportation permits, licenses, and appropriate insurance coverage. Inspections by state and federal agencies are strictly adhered to, and full preventative maintenance programs have been established for each vehicle or piece of equipment. Status reports for each hazardous waste vehicle and current state permits are available upon request.

Vessel Entry and Maintenance Cleaning: Vessel cleaning services are provided for all types and sizes, ranging from sulfuric acid storage to hydrocarbon tankage and PCB-contaminated tanks. Because vessel cleaning is an extremely dangerous task, safety and experience are the focal points in the maintenance cleaning program. All personnel take the following safety precautions:

- Use of a confined space entry team consisting of at least a three-man crew, with each man having specific roles and responsibilities.
- Completion of a thorough confined space work plan addressing all aspects of entry, exit, working conditions, emergency response, and safety requirements.
- Use of appropriate safety equipment, including but not limited to, safety harnesses, gas monitors, full air supply, and protective suits.
- Monitoring of staff members' health through annual physical examinations.
- Staff training and testing for confined space entry under full air requirements.

This insistence on safety, coupled with more than seventeen years of experience in vessel cleaning, allows Great Lakes Environmental to provide efficient and cost-effective services.

Several important factors have contributed to the success of this program. Before starting work on any project, Great Lakes Environmental conducts an on-site inspection to identify unusual conditions, to locate utilities, to obtain a sample if appropriate, and to define the logistics of entry, exit(s), and other conditions that may affect the progress of the work. Proper equipment is also critical to successful vessel cleaning. Great Lakes Environmental maintains a fleet of vacuum equipment of varied capacities, air support vans, portable pumps, safety equipment, explosion-proof lighting, non-sparking tools, and other specialty equipment to accomplish the job. Finally, staff members consult the chemical dictionary reference files to assure that all characteristics and special work requirements are identified and addressed.

Emergency Response: Great Lakes Environmental has been called upon to manage accidental spills for over 13 years. Such spills typically occur during the transport or transfer of materials such as petroleum products and industrial chemicals. The highly successful spill response approach developed by Great Lakes Environmental utilizes a five-step program:

1. *Assessment*: Management staff are available around the clock, 365 days per year. Assessment includes determining the nature and extent of the release, special handling and equipment requirements, safety restrictions, and the best method to control and eventually recover the material.

2. *Mobilization*: Technicians and the spill response equipment are mobilized to the scene of the release. Equipment is selected based on the unique needs and constraints of the site and the properties of the spilled material. All technicians are fully briefed on the particular hazards of the release, on safety equipment, and on their responsibility in the material containment and eventual cleanup.

3. *Containment*: Following mobilization, efforts are taken to eliminate the source of the release and to stop any further spread of released material. These efforts frequently require coordination with state and local regulatory and emergency response agencies.

4. *Surface Cleanup*: Spilled materials and adjacent affected areas are removed and either transferred to a containment area or transported in licensed vehicles to an appropriate disposal/treatment facility. Great Lakes Environmental will assist in selecting the proper handling method and disposal site if this has not been predetermined by the generator or a regulatory agency.

5. *Impact Assessment*: At the customer's request, Great Lakes Environmental can organize a team of specialists to prepare a study of the spill area and develop any necessary remedial action plans.

SUMMARY

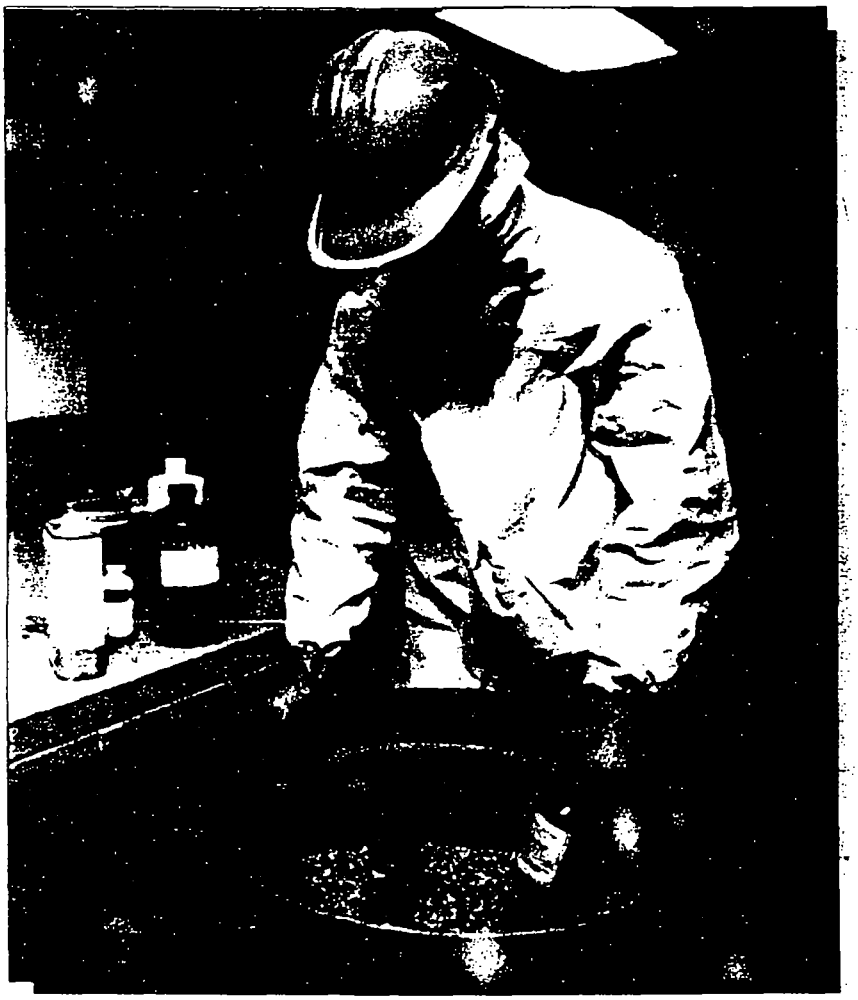
Great Lakes Environmental Services, Inc. is a diverse group of professionals committed to implementing sound environmental solutions to their customer's regulated waste problems. Great Lakes Environmental has met, and continues to meet, customer objectives through prompt service and integrity. For every customer and for each project, the company strives to minimize environmental liability by working safely and within regulatory guidelines.

Great Lakes Environmental welcomes the opportunity to show its facilities and equipment to customers firsthand. Professionally managed and well maintained facilities speak for themselves. Modern facilities and equipment can only operate effectively in the hands of qualified people. At Great Lakes Environmental, the emphasis is on safe, thorough, and conscientious service. The staff at Great Lakes Environmental has the experience and the training necessary to handle waste management effectively, efficiently, and within budget.

project experience

Project Title:

Lab Pack

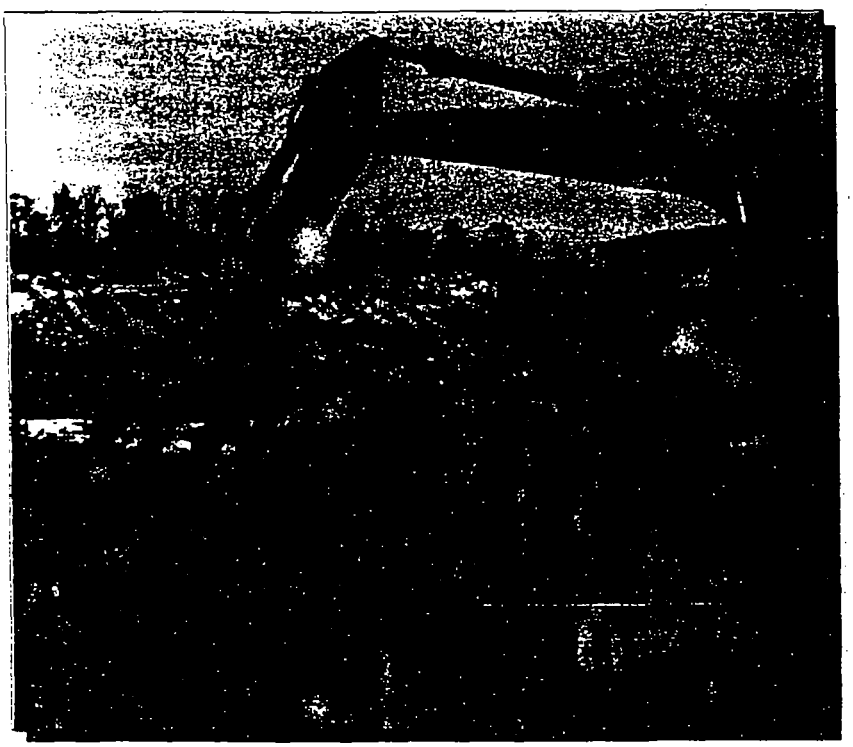


Services:

A major Midwest university accumulated an assortment of obsolete known and unknown chemicals that they wished to dispose of. Great Lakes Environmental was hired to classify, segregate, and package all materials for disposal. To supplement the limited amount of information that was available for the materials, Great Lakes Environmental used on-site laboratory screening procedures to evaluate each material which was then crosschecked through their computerized chemical dictionary. This chemical data-base served as a key tool in classifying approximately 2,000 known and 1,000 unknown chemicals, and 300 air, water or shock sensitive materials prior to packaging them for disposal. The work was completed in a 9-day period.

Project Title:

Lagoon Closure

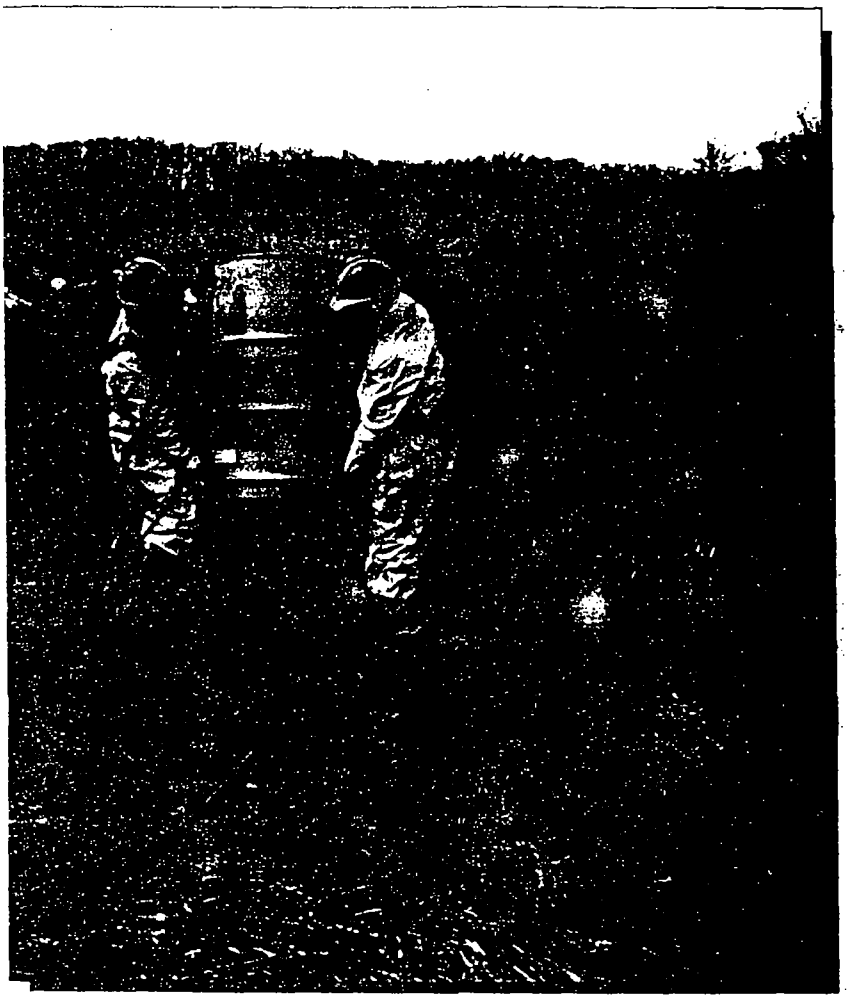


Great Lakes Environmental was hired to complete lagoon closure activities for an automobile manufacturer. The work included on-site investigations, sample collection, treatability evaluations, treatment and disposal. Mobilization was initiated ten days following authorization. Following a survey of the lagoon area and its sediments, representative samples were collected and bench tests were performed to determine dewatering characteristics and chemical fixation options. Based on these findings, Great Lakes Environmental contracted with the owner on a per cubic yard basis to perform chemical fixation, handling, and disposal services. Site preparation work included constructing service roads and access points to the lagoon. Following site preparation activities, fixation was performed using an injection machine. Work progressed with this machine working from on top of sludges which were already solidified. At the conclusion of chemical fixation efforts, 1,200 cubic yards of material were stockpiled, loaded onto dump trailers, and disposed of at an approved site. The entire job was completed 60 days after authorization.

Services:

Project Title:

Sampling

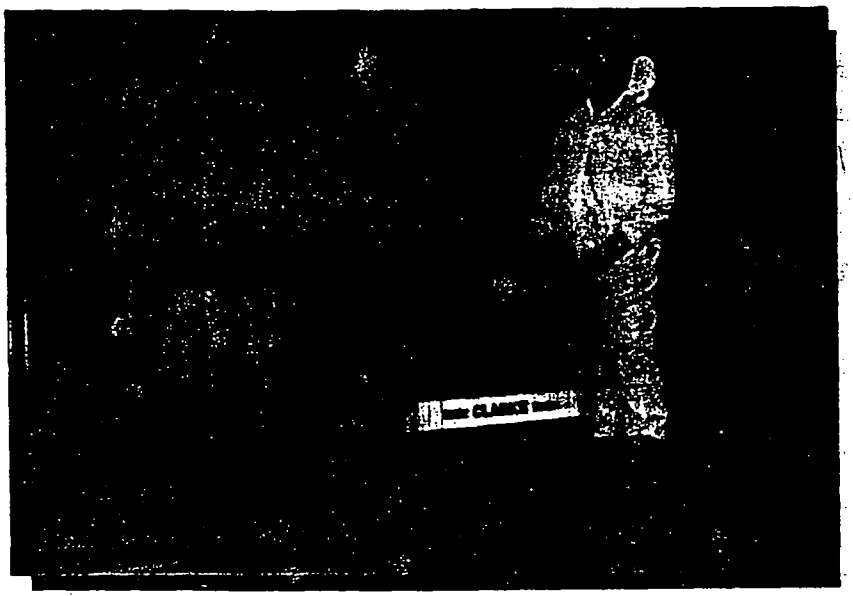


Services:

Great Lakes Environmental, through its Field Remediation Services and Technical Services divisions, was involved in the excavation, repackaging, staging, sampling, and screening of 1,200 drums from a closed landfill. By utilizing on-site field screening procedures, the work progressed smoothly and efficiently from start to finish. Each drum was excavated and inspected, then overpacked and taken to a staging area for sampling. Under the supervision of the Michigan DNR, three samples were taken from each drum. Field analyses were performed to establish the U.S. EPA hazard classification and the drums were coded and staged accordingly in a containment area built on the site. All work was performed under Level B protection.

Project Title:

Site Decontamination of an Electric Rebuild Facility



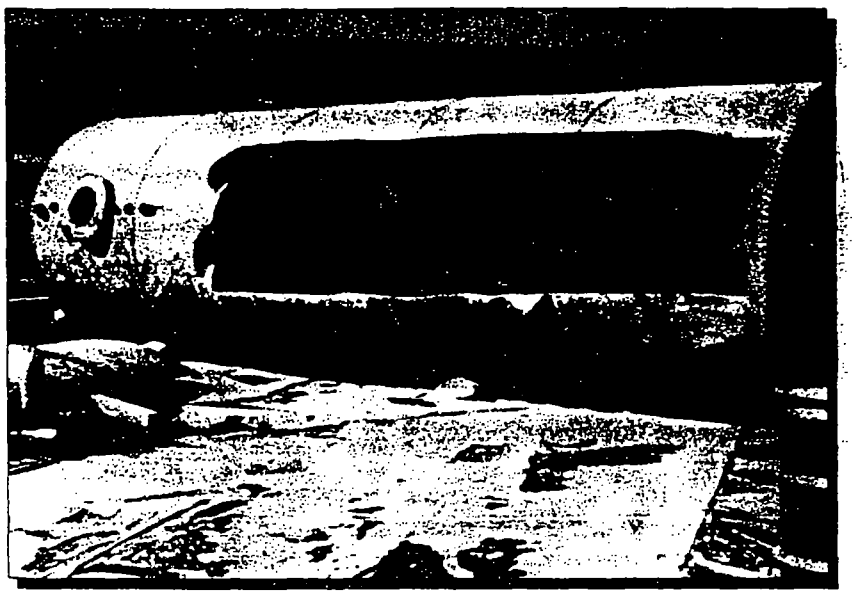
A large electric company ceased operations at one of its electrical rebuild stations where electric motors and transformers had once been repaired and rebuilt. Great Lakes Environmental was hired to collect samples from inside and outside the plant and analyze these samples for PCBs. Wipe samples were collected from inside surfaces such as floors and work areas, grab samples were taken of miscellaneous wastes, and soil samples were taken from areas surrounding the plant. The samples were then analyzed for PCBs to determine the extent of contamination and the potential disposal costs.

Services:

A clean-up crew of approximately 20 technicians were mobilized to the site to decontaminate the plant and package any contaminated materials for disposal. Areas within the 82,000 square foot facility were contaminated at levels up to 12,000 micrograms per 100 square centimeters. All areas were decontaminated with solvents. Waste and solvents generated during the cleaning process were then disposed of at a PCB incinerator. The entire facility decontamination was completed in approximately one month at a total cost of $200,000. Following decontamination, samples were submitted to the U.S. EPA to demonstrate compliance with pre-established clean-up guidelines.

Project Title:

Removal of Underground Storage Tanks



Great Lakes Environmental was hired by a manufacturing firm to remove nine underground storage tanks. The tanks varied in size from 500 to 10,000 gallons and contained waste oils, hydraulic oils, quench oils, solvents, and thinners. Great Lakes Environmental mobilized bulk tankers to the site to remove reclaimable oils and solvents. Cleaning crews then removed sludges from the bottom of the tanks. Following removal of bulk contents, personnel entered the tanks using Level B safety equipment and confined space entry procedures. The tanks were washed and rinsed until a zero lower explosive limit (LEL) level was met inside the tanks. The tanks were then excavated and transported to a salvage or disposal site.

Services:

During the excavation activities, it became evident that four of the tanks had leaked. A preliminary hydrogeological investigation was undertaken to determine how far the oils or solvents had migrated. Once the results were obtained from this investigation, excavation was resumed to remove approximately 500 cubic yards of contaminated soil. After all contaminated soils were removed, the excavated areas were backfilled, compacted, and capped with asphalt.

Project Title:

Pipeline Decontamination

Great Lakes Environmental was contracted by a national pipeline company to decontaminate sewer lines, machines, and floor areas, and to excavate lagoons and open ditches at a number of compressor stations.

The compressor stations had utilized PCB oils as a coolant in the equipment. A problem arose when those oils migrated into the condensate. When the equipment exhausted the condensate, it was discharged into the sewer system and then into the holding ponds. To ensure that contaminants did not leave the site, personnel from Great Lakes Environmental made provisions to secure all outfall piping. All affected equipment was decontaminated using a triple rinse with diesel fuel and a soapy water wash, followed by a clean water rinse. This process was repeated until desired cleanup levels were obtained.

After the machines and flow areas were decontaminated, Great Lakes Environmental began decontaminating the sewer system using industrial-type sewer cleaning equipment to remove the sludge and debris from the pipe. All material that was removed from the sewer system was sampled. If levels were above 50 ppm, the material was disposed of at a PCB disposal facility. After the sludges were removed, a triple rinse of diesel fuel was used to decontaminate the sewer system. On the third rinse, technicians collected and analyzed samples to see if concentrations were below acceptable levels. If not, the triple rinse was repeated until acceptable levels were achieved.

Services:

Great Lakes Environmental used crawler hoes, bulldozers, and front-end loaders to remove contaminated soils from the lagoons. The soils were stored on impervious liners prior to being transported to PCB-licensed disposal sites. Samples were collected from the lagoons to ensure that all PCB-contaminated soils had been removed. The lagoons were then backfilled to the existing grade, capped with six inches of top soil, and mulched. The completion time took 30 days per station, and the estimated cost was $150,000 per station.

Patrick J. Stock
President

As President, Mr. Stock is especially qualified to provide overall direction to the different divisions that comprise Great Lakes Environmental. Mr. Stock has served the company since 1970, and in that time he has come to know from experience all the levels of his business.

Mr. Stock joined Great Lakes Environmental Services as an operations technician and quickly became a field work supervisor. Thereafter, Mr. Stock, continued to take on increasing levels of responsibility. In 1976 he became a General Manager and in 1978 a Vice President. With his increasing knowledge of the business and his willingness to take on even more responsibility, Mr. Stock was promoted to the position of Executive Vice President in 1981 and assumed the primary leadership role in 1986 when he became President.

Mr. Stock knows his field of expertise from the ground up. In his time with Great Lakes Environmental, he has held all of the positions on the operational side of the company and has supervised many of the technical positions as well.

Mr. Stock is affiliated with the following professional societies:

Michigan Chemical Council (board member)
Associated of Environmental Professionals
Engineering Society of Detroit
Hazardous Waste Treatment Council
Associate of Iron and Steel Engineers

Charles D. Frazho
Controller

Mr. Frazho is responsible for all financial reporting and related accounting. After assuming this position with Great Lakes Environmental, Mr. Frazho completed an audit of the company's general ledger and its subsidiary functions. He restructured, updated, and streamlined the flow of transactions from the general office and plant to the overall accounting system. Mr. Frazho has designed and written new custom computer programs pertaining to environmental services. He has also written programs for specific departments within the company.

Prior to joining Great Lakes Environmental, Mr. Frazho served as the Treasurer for a manufacturer of steel pressure vessels. In that position, he was responsible for forecasting, budgeting, cash flows, credit and collections. Prior to that, Mr. Frazho served as Secretary-Controller for a manufacturer of illuminated ceilings.

Mr. Frazho's educational background includes:

University of Michigan, 1987
Studies in Management

Basic Four Corporation, 1985-1986
Programming I, II; Basic III

Boeing Computer Services, 1987
Introduction to Personal Computers

Robert J. Lawson
Manager, Eastern Region Sales

As Manager of Eastern Region Sales, Mr. Lawson is responsible for recruiting, maintaining, and supervising the Environmental Service Coordinators. Mr. Lawson also works directly with many of Great Lakes Environmental's customers to provide technical services.

Prior to joining Great Lakes Environmental, Mr. Lawson served as a District Conservationist for the United States Department of Agriculture. In that role, he was responsible for the design and implementation of non-point source pollution abatement projects, including extensive interaction with community representatives and with state and local governmental agencies. Mr. Lawson secured contracts with land users for the distribution of government funds for projects.

Mr. Lawson's educational background includes:

University of Wisconsin, 1979
B.S. Natural Resource Management

Michael J. Favor
Manager, Technical Services

Mr. Favor is responsible for day-to-day supervision of the Technical Services division. In this capacity, he is responsible for scheduling and coordinating all technical field crews and equipment, marketing, planning and development, quality assurance, project management, and liaison between other departments.

Mr. Favor has developed considerable experience with field remediation projects, including confined space entry, lab packs, field screening, sampling, and on-site project bidding and planning. He has worked within many diverse industrial and laboratory settings, which has given him a comprehensive understanding of a large variety of in-plant processes, waste generation activities, chemicals used in specific laboratory settings, and waste control problems produced by specific processes. In addition, Mr. Favor has experience with specialized sampling equipment, technical support vehicles, and field techniques used to identify and characterize unknown materials.

Prior to joining Great Lakes Environmental, Mr. Favor worked in the field of law enforcement. His responsibilities and training in that position included emergency response procedures, special weapons handling, fire fighting, advanced first aid, crowd control, regulatory interpretation, and enforcement of state and federal laws.

Mr. Favor's educational background includes:

University of Michigan, 1986
B.S. Environmental Science

Mr. Favor is a member of the following professional organizations:

Committee on Chemical Safety and the Environment-Detroit Section American Society

Beta Beta Beta (Biological Honor Society)

H. John Phelps
Director of Development

Mr. Phelps is responsible for the development of Great Lakes Environmental's transfer stations program, which includes all permitting and start-up activities.

He directs those environmental and waste assessment programs that relate to property transfers, mergers and acquisitions and refinancing. In addition, Mr. Phelps provides senior management review for all major customer projects.

Prior to joining Great Lakes Environmental, Mr. Phelps was president and chief operating officer of another environmental services firm. Previously, he held increasingly responsible positions in environmental affairs for Ford Motor Co., American Motors and Chrysler Corp., including manager of the facilities environmental affairs staff at American Motors/Chrysler.

A former environmental control engineer, Mr. Phelps has experience at every level of corporate environmental management, including policy development and execution, long range plans and budgets, and oversight of both internal staff and outside legal counsel.

Mr. Phelps' educational background includes:

Middle Tennessee State University, 1967
B.S. Plant and Soil Science

Henry Ford Community College
Courses in business, management, personnel and labor relations

Mr. Phelps is affiliated with the following organizations:

Environmental Auditing Roundtable
Engineering Society of Detroit
Michigan Chemical Council
Binational Public Advisory Committee
Detroit River Remediation
Delta Tau Alpha
National Agriculture Honorary Scholastic Fraternity

Craig L. Bell
Project Development

Mr. Bell is responsible for preparing work plans and proposals for large remedial action projects. This includes project costing calculations, contract document review, execution of subcontractor agreements, periodic technical and supervisory field activities, and review of project financial audits.

His work with Great Lakes Environmental has focused primarily on development of proposals for underground tank removals, lagoon closures, plant decontamination, above-ground tank decontamination, PCB cleanups, and various RI/FS-related work requested by environmental consulting firms.

Prior to joining Great Lakes Environmental, Mr. Bell was the office manager for the Michigan Division of the Technical Assistance Team under contract to the U.S. EPA. His responsibilities including scheduling, training, purchasing, oversight of property control, acting as a technical resource, quality assurance, and field quality control audits of CERCLA paperwork. Mr. Bell was also involved in RCRA, TSCA, and SPCC compliance inspections; evaluating, proposing, and managing U.S. EPA Superfund Emergency Actions; and determining the proper extent of contamination sampling techniques that allowed for cost recovery litigation with responsible parties.

Mr. Bell's educational background includes:

University of Michigan - Dearborn, 1982
B.A. Environmental Studies

board of directors / shareholders

BOARD OF DIRECTORS

In addition to Patrick J. Stock who is Chairman, the Board of Directors is comprised of the following three additional members - Steven Bouck, John Cannon, Sr., and Steven Tadler.

Steven Bouck is employed by First Analysis Corporation (FAC) of Chicago, Illinois. He provides research expertise in laboratory equipment and services, the management of regulated wastes, and computer-aided publishing. He joined FAC in 1986 after he received an M.B.A. in Finance at the Wharton School and a B.S., Magna Cum Laude, and M.S. in Aeronautical Engineering at Rensselaer Polytechnic Institute. Prior industry experience includes marketing Hewlett-Packard computer products for technical applications and marketing a variety of computer equipment as an independent manufacturer's representative with Remtek, Inc. He has also worked as an Engineer for Dresser Industries and the Jet Propulsion Laboratory.

John Cannon, Sr. has been associated with the Detroit based law firm of Dykema, Gossett, Spencer, Goodnow, and Trigg since 1957 and became a partner in 1967. He is currently Managing Partner of the firm's 40 lawyer Oakland County office located in Bloomfield Hills, Michigan. In addition to being a director of Great Lakes Environmental Services, Inc., Mr. Cannon has been a director of Michigan Rivet Corporation and National Mobile Concrete Corporation. Mr. Cannon graduated from Yale University with a B.A. degree in 1954. He then attended the University of Michigan Law School, graduating with a J.D. degree in 1957.

Steven Tadler is a Senior Investment Manager with Advent International. Mr. Tadler received a B.S. with distinction from the University of Virginia. Mr. Tadler also received an M.B.A. from the Harvard Business School. Prior to joining Advent, he was an officer of Manufacturers Hanover Trust Company in New York where he managed finance for the acquisition of technology-orientated firms and other special situations. Mr. Tadler is also a director of Advanced Composite Products, Vantage Corporation International and Pollux Corporation.

SHAREHOLDERS

Great Lakes Environmental is a management/investor-owned company. The investor shareholders are Advent International Corporation, Environmental Systems Company, First Analysis Corporation, and Sequoia Capital. The organization provides the necessary capital support for continued growth of Great Lakes Environmental.

Advent International (AI), established in 1984, is a private corporation engaged in the management of development capital. the Advent Network created by Peter Brooke represents the most comprehensive and sophisticated network of companies in the world.

The Advent Network has become the leading force in the rapidly developing international development capital industry. It has member firms operating in nine European and five East Asian countries, as well as Australia and the United States. Each member firm is a leader in its home market, manages its own pool of capital and is staffed by highly qualified local nationals. In total, the Network has raised over $1 billion of capital and has investments in more than 300 portfolio companies around the world.

Advent International is engaged in development capital investing, as well as providing merger and acquisition, strategic planning and operational services to the members of the Advent Network, its corporate clients, and other companies who wish to become involved in strong regional economics throughout the world.

For portfolio companies, Advent International provides both capital and operational support, including access to international markets and the establishment of offshore manufacturing. AI often arranges strategic alliances between its portfolio companies and major corporations. AI provides marketing assistance, strategic planning and budgeting, as well as a sophisticated international perspective.

The combined resources of the Advent Network and the multidisciplinary skills of Advent International's professional staff make it possible for AI to offer both its investors and its portfolio companies a range of services not available from traditional capital firms.

Environmental Systems Company (ENSCO) is a publicly traded (NYSE: ESC) company which has recently reorganized in order to focus on the business of regulated waste disposal. The company is based in Little Rock, Arkansas and has annual sales of approximately $70 million. ENSCO operates a state of the art regulated waste disposal facility located in El Dorado, Arkansas.

First Analysis Corporation (FAC) is an investment research organization which began to offer services early in 1982. FAC endeavors to build, identify, and maintain long-term growth ideas that improve productivity and/or manage processing of all types of waste output through technological development financing.

Many major financial institutions and corporations use FAC research in making investment decisions and keeping abreast of new developments. Research is used by institutional investors for the public markets and by FAC internally to identify and evaluate private venture investment opportunities. FAC is the general managing partner of three venture funds with an aggregate capitalization of $85 million. Of the three, the Environmental Venture Fund (EVF) is the premier investment fund serving the waste processing industry.

Environmental Venture Fund addresses the growing number of investment opportunities resulting from the regulatory effort to preserve our environment. The Fund closed for investment at $37 million in 1988. The general partnership includes William D. Ruckelshaus Associates; Felsen, Genack Associates; and Robertson, Coleman and Stephens. In addition, Kidder Peabody & Co., Inc. is a special limited partner. The Fund invests in high growth companies (both existing and new) with services, technologies, and products in diverse sectors of the regulated waste management industry.

Sequoia Capital manages a $100 million family of venture capital funds and will finance the growth of every stage of a young, private company. Since being formed in 1973, Sequoia Capital has invested in more than 175 companies. Sequoia is managed by a team of experienced partners who have started, built and operated large and successful companies. In addition to supplying capital, they are firmly committed to helping to devise strategies for long-term growth, arrange additional equity, lease and debt financing, located potential business partners, and participate in growth through mergers or acquisitions or through development of internal strengths.

appendix: transportation equipment

TRANSPORTATION EQUIPMENT

DESCRIPTION	NUMBER OF UNITS	SIZE/ CAPACITY	USES - SPECIAL FEATURES
Vacuum Tankers	1	2,500 gallons	500 CFM vacuum pump; steel full open back door with hydraulic tilt
	2	3,000 gallons	900 CFM vacuum pump; steel full open back door with hydraulic tilt
	3	6,000 gallons	DOT coded for flammable materials; two units mild steel; one unit stainless steel
Bulk Tankers (gear pump loading)	2	10,000 gallons	Eight axle; 304 stainless steel; DOT coded for corrosive and flammable materials
	2	8,000 gallons	Three axle; 307 stainless steel; DOT coded for corrosive and flammable materials
	3	6,700 gallons	Three axle; 304 stainless steel; DOT coded for corrosive and flammable materials
Freight Vans, Flat Bed, Dump Trailer	4	45 foot	Freight van
	1	48 foot	Flat bed-full side kit; chains; fully covered
	1	30 cubic yards	Dump trailer fully covered
Rolloff Trailers	2	20 cubic yards	Three axle units with gross vehicle weight capabilities of 80,000 pounds
	25	20 cubic yards	Containers-fully licensed for hazardous waste and PCB transport

TRANSPORTATION EQUIPMENT continued

DESCRIPTION	NUMBER OF UNITS	SIZE/ CAPACITY	USES - SPECIAL FEATURES
Power Units	3	Tandem axle	General Motors tractor
	1	Tandem axle	Ford tractor
	5	Tandem axle	Kenworth tractor
Fresh Air Support Systems	2	Ambient air/ cascade air support systems	Able to provide fresh air to ten men for eight hours while working in a confined space or contaminated atmosphere
Decontamination trailer	1	10 men	Full service strip-down area, four showers, ten lockers and clean area. Fully air conditioned, self-contained facility
Heavy Construction Equipment (subcontracted)	2		Hi-lo/lift truck-drum handling capabilities
	3	2 yards	Rubber tired loaders
	3	1-3 cubic yards	Crawler backhoes with drum grappler (spark proof 360° articulation)
	3		Caterpillar and John Deere-bulldozers with power assist winching equipment
	1		Road grader
Drum Crushing Equipment	1		Hydraulically operated with full spark and operational safety design

Miscellaneous Project Equipment:

Fuel supply trailers, portable lighting system, various size pumping equipment, ventilation air blowers, space heating equipment (blower and radiant), steam cleaning equipment, portable arc welding equipment, portable pressure washing and decontamination equipment, pickup and stake trucks, chainsaws, compactors, and sand blasting equipment.

In addition to the transportation and project equipment listed above, Great Lakes Environmental is capable of securing any equipment needed to perform a task.

QA/QC DOCUMENTATION

ANALYTICAL & BIOLOGICAL LABORATORIES

QUALITY ASSURANCE / QUALITY CONTROL

MANUAL

CONTENTS

SECTION I

LABORATORY QUALITY CONTROL/QUALITY ASSURANCE PROGRAM

INTRODUCTION

Laboratory quality assurance is often considered the most important part of an organized quality assurance program. It is actually only one of the essential components. The often asked question, "how good is this particular value?", should often be answered with "how good was the sample as delivered to the laboratory?". If the sample is not representative of the original site; has not been collected in a suitable container; has not been preserved using the required technique and cannot be analyzed within the recommended maximum holding time, any effort the laboratory makes to document its accuracy or precision is generally of minimal value. Quality assurance must begin in the minimal value. Quality assurance must begin in the program planning stage and be carried through to how the final data is interpreted and utilized.

QUALITY CONTROL VS. QUALITY ASSURANCE

The terms quality control and quality assurance are quite often misunderstood and incorrectly used interchangeably. Laboratory quality control consists of those internal operations which are performed during the measurement process to document data quality (eg. split samples, spiked samples, reagent blanks, instrument calibration checks, etc.). Laboratory quality assurance consists of those activities performed with less frequency to obtain independent assessments of operating conditions (eg. independent reference samples, interlaboratory comparison studies, laboratory evaluation samples, etc.).

Documentation of Methodology

Before the results which are reported by the laboratory can be of any value, the analytical methods used must be appropriate for the particular sample type, be capable of performing with the necessary sensitivity and produce data which is free of bias. Environmental Laboratory Procedure No. PD-14: "Methodology Approval" addresses the correct procedure for evaluating whether a method is capable of performing adequately. There are many standard laboratory references (eg. Standard Methods for Examination of Water and Wastewater, 1975, APHA-AWWA-WPCF; "Methods for Chemical Analysis of Water and Wastes, US EPA, March 1979, EPA-600-/4-79-020; Annual Book of ASTM Standards, Part 31; etc.) which have documented most of the more common environmental laboratory procedures.

The current Federal Register "List of Approved Test Procedures" should be consulted before initiating use of particular methodology. This list, compiled by the U.S. Environmental Protection Agency for Analysis of NPDES compliance monitoring samples, references the methods deemed most appropriate for analysis of environmental water samples. Whenever practical, an "EPA approved" method should be employed. If a "better" method (eg. more accurate, improved efficiency, greater sensitivity, better precision, lower operating cost, etc.) is available, it has to be compared to an approved method to demonstrate equivalency. The EPA Regional Administrator must also approve its applicability for use on certain Federally-funded programs, especially NPDES compliance monitoring. Formal application following an established protocol should be followed for alternate test procedure approval.

Although most methods in use in the laboratory closely parallel standard referenced procedures, the exact laboratory method in use should be well documented and a copy maintained at the bench for easy accessibility. Environmental Laboratory Procedure No. PD-15; "Methodology Write-Up Format" explains a proper manner of writing laboratory methods. A standardized format improves readability of laboratory methods. Any deviations from standard references should be carefully noted and any interferences encountered during routine laboratory testing explicatively described.

ANALYST CERTIFICATION

Once a method has been proven to be suitable for certain samples, the analyst performing the analysis must demonstrate proficiency with the particular analytical technique. Environmental Laboratory Procedure No. PD-16 "Analyst Certification" details the necessary steps. During the "Methodology Approval" procedure, the expected performance of a method is established. The performance of the analyst should be checked against past standards and any significant variations investigated. Only after analysts have proven capable of generating valid data should their results be reported.

LABORATORY QUALITY CONTROL CHECKS

The Measurement of Precision

Quite often a data user will inquire as to the precision of a particular method or parameter. Depending on the parameter this may be fairly easy or quite difficult to establish and the precision of any individual value would be very sample dependent. Because precision is an estimate of procedural variability, it is often derived from the measurement of duplicate aliquots of samples or standards. Precision is usually expressed as a standard deviation and can be calculated by any of the following procedures.

1. Precision as determined by Between-Run Duplicates.

Between-run duplicates are two separate aliquots from one sample which are analyzed separately in two analytical batches. This approach cannot be used with labile parameters but works best when there is sufficient volume of sample and the constituents of interest are conservative. The reliability in your estimate of the population standard deviation increases with increased population size. Forty to fifty pairs of data are desirable for an initial estimate, although fewer pairs may be used if that's all the value that are available.

Table 1 consists of 48 sets of data which can be statistically analyzed for the purpose of setting quality control limits. For each sample, consider the first values and the second values as having been analyzed in two separate runs or batches of samples. The range is the absolute difference between the two values. When there is no measurable difference in a pair (Samples 1, 8, 14, 17, 42, 45 and 47), the recorded difference is reported as one half of the minimum sensitivity of the analytical system. This is necessary because some analytical systems are fairly insensitive and little or no difference may be measured in paired samples when calculating control limits, which results in artificially low limits. Any measured difference on a sample pair may then indicate an out-of-control situation.

Each set of data could be evaluated using more than one method. Any gross outliers should be immediately rejected and not included in further evaluation. Questionable data should be included initially and be rejected after preliminary evaluation. First, the mean range is calculated:

$$\bar{R} = \frac{\Sigma R}{n} = \frac{0.1515}{48} = 0 \cdot 00316$$

where R = mean range

R = individual range values

n = number of values in group

The standard deviation, s, can be estimated by dividing the mean rage, R, by 1.13 and obtaining 0.00279 mg/l. It is generally customary to use "3 σ" limits for most control charts. This is equivalent to a Type 1 error 0.003, meaning that there would be three chances in 1,000 of calling the system out-of-control when it is not. The precision control limit for this method 0.0084 mg/l. Any time a range value for precision is higher than this, the test would be shutdown, any problems located and corrected and all suspect run of samples repeated. This limit suggests the system was out-of-control for samples 25, 28, 29 and 30.

With most analytical methods, the standard deviation increases as concentration of the analyte increases. This was not taken into account in our previous example. One method of checking for this is a linear regression analysis of the mean concentrations of the paired values versus the range of the difference of the paired values. A statistical analysis of the values in Table 1, excluding sample 25 and 29 because of their high range values, results in a line with a slope of 2.00 %, y-intercept of 0.00126 mg/l and a correlation coefficient of 0.597. 3 σ control limits as calculated from this method would range from 0.0034 mg/l at the lower end of the analytical working range to 0.0297 mg/l at the upper end (0.500 mg/l). This method of analysis indicates that samples 7, 25, and 29 were out-of-control in relation to desired precision.

The linear regression approach to precision analysis is quite often not a valid approach. If a statistical analysis results in correlation coefficient lower than 0.050, it should be probably not be applied to further use. One exception would be if the precision of a test actually improved higher concentration. Then a correlation coefficient less than 0.050 may be acceptable. Correlation coefficients between <0.50 and 0.50 would indicate a general liability to estimate an acceptable precision based on the concentration of samples. Another serious problem with this particular approach is that the line which is derived is based on the data which is available and if the whole analytical working range of a method is not well defined, the line may not be applicable for the whole range. This is sometimes noted by a negative y-intercept.

Still another approach which can be used to allow for increased imprecision over the analytical working range of a test is to segment the results into narrower bands. If the sample values in the Table 1 are dichotomized such that the values below 0.050 mg/l and those above are analyzed separately, there are 26 sets of values in lower group and 22 sets in the higher group. The mean range for the lower group is 0.0018 mg/l, which is equivalent to a standard deviation of 0.0016 mg/l and three precision control limits of 0.0048 mg/l. For the higher group, the mean range is 0.0046 mg/l, the standard deviation is 0.0041 mg/l and the 3σ control limit is 0.0122 mg/l. From this method of analysis, samples 7, 25, and 29 are again out-of-control relative to precision. This approach is valid when sufficient segments are used adequately to decide when a system is truly in a state of control. The above example should have a third intermediate segment so that the break at 0.0050 mg/l is not so great (0.0048 mg/l below versus 0.0122 mg/l above).

Although each of the three above examples are significantly different in their approach to precision control, they all agree that the samples 25 and 29 were out-of-control. Additionally samples 7, 28 and 30 were also deemed out-of-control by at least one of the three methods. The method of choice depends on the particular analytical method of interest and individual preference. Some methods may require an entirely different approach to the control of precision.

2. Precision as determined by Within-Run Duplicates.

With non-conservative parameters, between-run duplicates may be impractical and within-run duplicates would give a better estimate of precision control. This could be seen on between run duplicates if the second value was routinely lower (or higher) than the first value due to chemical degradation and should be expected with parameters having short holding times. The interpretation of data would be the same as in the previous example, but the two sample values and spike value for each sample in Table 1 would be interpretated as having been analyzed in a single analytical batch. The major disadvantage of this approach is that systematic errors (usually calibration problems) would be much less noticeable.

Use of Precision Control Charts.

Quality control charts are often used to evaluate daily performance. Dr. Walter A. Shewhart of Bell Telephone Laboratories is credited with the development of the basic theory of control charts, for which reason they are often called Shewhart quality control charts. Their main value is a graphic representation of the state of control at a given time compared to the past trends and established limits. The industrial approach has been modified over the years to accommodate use in environmental laboratory situations.

Figure 1 shows the precision control chart for the values in Table 1 when the ranges of the duplicate values are plotted against sample number. Generally the x-axis would have direct relationship with time, but the data in Table 1 was not collected in that manner. If the values are considered as having been plotted in chronological order, it could be stated that for the period of time from samples 25 through 30, the analytical system was out-of-control relative to expected precision. Any range value from duplicate sample which exceeds the established precision control (0.0094 mg/l for the example used in Figure 1) would result in an immediate investigation into the source of excessive deviation, a correction of the problem and an additional analysis of all suspect values. If unable to repeat questionable results due to insufficient sample volume or expiration of the maximum holding time, no laboratory result or a coded value should be reported by the laboratory unit supervisor. From Figure 1, excessively large precision control problems existed for samples 25 and 29. There were smaller problems for samples 28 and 30.

Figure 2 is a precision control chart from the data in Table 1 when the ranges of the duplicate values are plotted against the mean sample concentrations. The slanted dashed line is the line of best fit as defined by linear regression analysis. The solid slanted linear regression control limit is derived from multiplying the y-intercept and slope by 2.65 (equivalent to division by 1.13 conversion of mean range to standard and multiplication by three to establish three control limits). Sample 7 is slightly out-of-control and gross precision control problems exist for samples 25 and 29.

Figure 3 is a precision control chart from data in Table 2 with the ranges also plotted against the mean sample concentration. Mean sample concentrations below 0.050 and over 0.050 mg/l were analyzed separately and the corresponding 3 control limits were plotted for each segment. The same samples were out-of-control by this method as by the previous method.

The Measurement of Accuracy

The accuracy of any method is more difficult to define and the accuracy of an individual sample analysis may not be capable of definition. Attempts to measure accuracy are hindered by the imprecision of the analysis, possible incomplete recovery of digestion of extraction step and the presence of unknown interferences which could cause high or low biases. A method may be considered as accurate if none of the steps in the analytical procedure introduce a variable bias and there are no common interferences. A nonvariable bias, such as 90 % recovery in an extraction step, can be handled by proper calibration of standards. A variable recovery should be sufficiently documented so that data users can establish confidence intervals for results.

TABLE 1
EXAMPLE OF PRECISION AND ACCURACY DATA
Sample Values in mg/l

Sample Number	1st Value	2nd Value	Range	Spiked Value	Spike Recovered	% Recovery	% Bias
1	0.033	0.033	0.0005	0.152	0.119	119.	+19
2	0.020	0.023	0.003	0.113	0.0915	91.5	-8.5
3	0.038	0.036	0.002	0.129	0.092	92	-8
4	0.018	0.019	0.001	0.116	0.0975	97.5	-2.5
5	0.021	0.022	0.001	0.113	0.0915	91.5	-8.5
6	0.046	0.045	0.001	0.134	0.0885	88.5	-11.5
7	0.045	0.039	0.006	0.134	0.092	92	-8
8	0.018	0.018	0.0005	0.109	0.091	91	-9
9	0.035	0.039	0.004	0.124	0.087	87	-13
10	0.013	0.014	0.001	0.111	0.0975	97.5	-2.5
11	0.003	0.006	0.003	0.101	0.095	96.5	-3.5
12	0.011	0.013	0.002	0.099	0.087	87	-13
13	0.045	0.043	0.002	0.133	0.089	89	-11
14	0.027	0.027	0.0005	0.128	0.101	101	+1
15	0.016	0.013	0.003	0.110	0.0955	95.5	-4.5
16	0.043	0.040	0.003	0.131	0.0895	89.5	-10.5
17	0.021	0.021	0.0005	0.114	0.093	93	-7
18	0.014	0.015	0.001	0.102	0.0875	87.5	-12.5
19	0.045	0.041	0.004	0.133	0.090	90	-10
20	0.018	0.016	0.002	0.106	0.089	89	-11
21	0.010	0.011	0.001	0.108	0.0975	97.5	-2.5
22	0.019	0.021	0.002	0.112	0.092	92	-8
23	0.006	0.005	0.001	0.098	0.0925	92.5	-7.5
24	0.008	0.007	0.001	0.101	0.0935	93.5	-6.5
25	0.075	0.059	0.016	0.154	0.087	87	-13
26	0.018	0.020	0.002	0.114	0.095	95	-5
27	0.023	0.022	0.001	0.118	0.0955	95.5	-4.5
28	0.192	0.183	0.009	0.272	0.0845	84.5	-15.5
29	0.093	0.112	0.019	0.183	0.0805	80.5	-19.5
30	0.316	0.307	0.009	0.386	0.0745	74.5	-25.5
31	0.168	0.171	0.003	0.258	0.0885	88.5	-11.5
32	0.284	0.278	0.006	0.365	0.084	84	-16
33	0.107	0.106	0.001	0.206	0.0995	99.5	-0.5
34	0.060	0.055	0.005	0.142	0.0845	84.5	-15.5
35	0.084	0.087	0.003	0.177	0.0915	91.5	-8.5
36	0.096	0.098	0.002	0.186	0.089	89	-11
37	0.085	0.079	0.006	0.177	0.095	95	-5
38	0.063	0.059	0.004	0.153	0.092	92	-8
39	0.087	0.090	0.003	0.190	0.1015	101.5	-1.5
40	0.061	0.060	0.001	0.160	0.0995	99.5	-.5
41	0.097	0.090	0.007	0.190	0.0965	96.5	-3.5
42	0.053	0.053	0.0005	0.149	0.096	96	-4
43	0.097	0.096	0.001	0.190	0.0935	93.5	-6.5
44	0.131	0.130	0.001	0.226	0.0955	95.5	-4.5
45	0.081	0.081	0.0005	0.176	0.095	95	-5
46	0.112	0.113	0.001	0.203	0.0905	90.5	-9.5
47	0.080	0.080	0.0005	0.173	0.093	93	-7
48	0.069	0.065	0.004	0.167	0.100	100	0

One of the most common methods of measuring accuracy is through spike recovery, where another measured aliquot of sample is taken spiked with a known amount of analyte, analyzed in the same manner, then the recovery of spike is calculated as follows:

$$\% \text{ RECOVERY} = \frac{\text{SPIKE SAMPLE CONCENTRATION} - \text{UNSPIKED RESULTS}}{\text{THEORETICAL SPIKE}} (100)$$

So, if a sample containing 0.053 mg/l of analyte is spiked so that an additional 0.100 mg/l should be found and a value of 0.149 mg/l is obtained, the % recovery would be 96 %.

$$\% \text{ RECOVERY} = \frac{0.149 - 0.053}{0.100} (100) = \frac{.096}{.100} (100\ \%) = 96\%$$

If % bias is preferred, subtract 100 % from your % recovery value.

$$\% \text{ BIAS} = \% \text{ RECOVERY} - 100\ \%$$
$$= 96\% - 100\ \% - 4\%$$

Our previous example indicated a 4 % low bias.

In Table 1, the data in the "Spiked Value" column was obtained by analysis of an aliquot which had been spiked to an additional concentration of 0.100 mg/l. The amount of spike and a % bias are calculated for each sample using the mean of the first and second value for each sample. The standard deviation of the spiking recovery procedure is found to 0.0066 mg/l. The mean of the differences from the expected spike is -0.0075 mg/l (% bias of -7.5%).

The absolute value of the mean (0.0075 mg/l) is greater than the standard error of the mean of the spiking recovery procedure (0.0065/48 = 0.00094 mg/l), which indicates that the spiking recovery procedure is biased. A low recovery (92.5%) would be expected as normal. Control limits set from this data would be for 0.0925 +/- 3 x 0.0065. or from 0.073 to 0.112 mg/l as an acceptable recovery on the spike. The only out-of-control sample was number 1 which had a higher than acceptable recovery (119%).

Figure 4 is an accuracy control chart for the data in Table 1. In addition to halting analyses when an out-of-control situation exists, any trends should be noted and evaluated before serious problems arise.

The routine low bias in the above example indicates a problem with the analytical procedure, the method of measuring accuracy, or a combination of the two. If the problem is with the method of analysis, the step causing low bias should be located and changed. Some analytical procedures may allow for a recovery correction factor. If the problem is due to the method of evaluating the accuracy of the method, necessary changes should be made so that a valid audit is obtained. Possible sources of poor spike performance are a bad spiking standard (which should be prepared independently of calibration standards), improperly calibrated micro-pipets, improper use of micro-pipets, large spiking volume causing volume correction problems, too small spiking volumes causing excessive spike deviation and sample matrix interferences.

The measurement of accuracy through spike recovery is not applicable for many parameters (pH, specific conductance, dissolved oxygen, suspended solids, biochemical oxygen demand, bacteriological determinations, etc.) and are impractical for some sample matrices (tissue, sediment, oils, etc.). For these samples, other forms of accuracy control should be investigated and utilized.

Other common methods of evaluating operating accuracy is the use of a stable standard, a standardized natural sample for which an expected value has been determined or a standard reference material (available from the National Bureau of Standards, etc.). The accuracy data from these three examples would be interpretated similarly. Consider the values in Table 2 as either having been collected from a single analysis of either a stable standard, stabilized natural sample or standard reference material in fifty separate analytical batches. The "true" value in 25.0 mg/l. The mean value of all the data is 24.97 mg/l with a standard deviation of 0.94 mg/l. Using 3 standard deviation control limits, the system is in control for standard values from 22.2 mg/l to 27.8 mg/l, indicating an out-of-control situation for samples 22 and 26. When these values are excluded, the new mean and standard deviation are 25.00 and 0.53 mg/l respectively. The proper control limits would be from 23.4 to 26.6 mg/l. A standard value outside this range would suggest that a problem with the accuracy of that set existed and that the batch should be repeated after the appropriate corrective measures have been taken.

TABLE 2

TABLE 2
EXAMPLE OF ACCURACY DATA
Standard Value in mg/l

Sample Number	Standard Value	Sample Number	Standard Value
1	25.1	26	28.3
2	24.7	27	25.5
3	24.3	28	24.8
4	25.0	29	24.2
5	25.6	30	24.9
6	25.5	31	25.7
7	25.2	32	25.3
8	24.6	33	25.2
9	24.4	34	24.2
10	25.2	35	25.1
11	25.9	36	25.0
12	25.1	37	25.9
13	25.2	38	24.7
14	24.3	39	25.0
15	24.9	40	24.9
16	24.4	41	24.1
17	25.5	42	24.7
18	24.3	43	24.9
19	25.6	44	25.7
20	25.9	45	25.5
21	24.1	46	25.2
22	20.6	47	25.0
23	24.9	48	24.7
24	25.2	49	24.1
25	26.0	50	24.6

Equipment Logbook

To insure that all laboratory equipment and apparatuses are operating properly and are routinely maintained, equipment logbooks should be maintained by the analysts. Each analyst and unit supervisor should decide what equipment should be checked, what variable should be monitored, the frequency and type of monitoring and establish a routine maintenance schedule as necessary, "Quality Assurance Practice and Procedures", U.S. EPA, Region V should be consulted as a guideline.

Reference Sample Evaluation

Reference samples should be prepared, analyzed and evaluated periodically (usually quarterly) as an independent audit of laboratory performance. The U.S Environmental Protection Agency distributes sets of many parameters upon request and other sets are commercially available (Environmental Resource Associates, etc.). They are of a primary value as an outside check on calibration standards and are useful in evaluating new methods. Although "true" values are supplied with reference samples, analysts should analyze reference samples without previous knowledge as to the expected values unless some idea of the expected range is necessary to establish the best method of analysis or proper dilution. If more than one method of analysis is routinely employed or more than one analyst commonly performs certain analyses, each method and analyst should be evaluated separately. The values reported by the analysts should be compared to the "true" values and the bias and % bias calculated for each result. Besides evaluating each sample statistically, careful attention should be paid to any trends. A five percent low result on one sample may be acceptable, but five percent low results on all samples for a parameter may indicate a correctable low bias.

Interlaboratory Comparisons and Evaluations

As an additional check on laboratory performance, all interlaboratory comparisons and evaluations should be participated in if the parameters and matrices under study are routine laboratory analyses. The International Joint Commission periodically conducts interlaboratory comparisons covering a variety of parameters in different matrices. The U.S. Environmental Protection Agency annually conducts laboratory evaluation studies. When the results are evaluated and returned (which may take several months), the conclusions of the studies should be confirmed and any necessary corrective measures taken. Values for non-routine laboratory parameters should not be reported for evaluation because they do not reflect laboratory performance and may create incorrect impressions as to the quality of results reported by the laboratory.

Calibration

Instrument calibrations should be established or confirmed with each batch of analyses or more often as necessary. If analytically practical, methods with linear responses should be calibrated with a baseline control or blank (0 % full scale), a mid-scale standard (40 - 60 % f.s.) for calibration, and high standard (80 - 100 % f.s.) to verify linearity and slope calibration and a low standard (5 - 20 % f.s.) to verify the blank or baseline. Parameters which conform to Beer's law should only be evaluated using a linear regression (first order polynomial) fit. Using a higher order fit would result in masking bad calibration points and improper calibration. A minimum of four points is desirable so that a bad calibration standard should be determined and rejected. Most "good" linear methods will result in a correlation coefficient of 0.98 or higher. A lower correlation coefficient would suggest an erratic test, a bad calibration standard or a non-linear response. Three control limits should be applied to the appropriate calibration checks as determined by the unit supervisor and analyst.

Non-linear methods require additional calibration points to define the working curve. Five to seven or more calibration points should be used depending upon the complexity of the analytical curve. A simple parabola can be defined by a non-linear regression analysis using a second order polynomial fit. Use of five calibration points will allow identifications and rejection of a bad point. More complex curves will require other approaches to calibration curves and should be handled on a case by case basis.

FIELD SAMPLING QUALITY CONTROL

Introduction

To obtain a valid quality control assessment, certain steps must be taken by field sampling personnel. These should definitely include field replicates and blanks, and may additionally include split samples, field spikes into samples and field spikes into laboratory distilled water. The results from these field audits may be independtly evaluated by proper trained personnel for maximum effectiveness.

Field Replicates

Field replicates are simultaneous independent samples taken from one sampling point. Depending on the parameters, these may be side-by-side grab samples or composite samples mounted in parallel. Samples should be identified as replicates when submitted to the laboratory for maximum utilization of them. The main purpose of a field replicate is to provide additional sample for laboratory quality control and check on the variability of the sample. Many organic parameters require that all of the sample be used for a single analyses. Also, the quality control data generated by the laboratory from a single sample container may not be indicative of the true variability of the sample concentration, but only of the variability introduced by the laboratory, which may be a small portion of the variability. All programs should have about four percent (one out of twenty-five samples) replication.

The advantages of notifying the laboratory as to the duplicate nature of samples over "blind" replicates lies in their potential maximum use if properly reviewed. The variability found in field duplicates should be checked against the expected variability of laboratory precision. Significant differences should be investigated as thoroughly as possible. If sufficient sample volume remains, the sample can be repeated to verify laboratory values. Causes for excessive variability not due to laboratory precision should try to be located and corrected and if unable to remedy, properly documented as to the extent of variability. "Blind" replicates are seldom used for more than an informal audit of laboratory performance.

Field Blanks

Field blanks are very important as a check on the cleanliness of sample containers, the purity of any chemical preservatives and possible contamination due to improper sample handling. Sample bottles containing laboratory prepared water (deionized - distilled or whatever is deemed more appropriate) should be picked-up at the laboratory with sample bottles for surveys or projects. Field blank bottles should be required with other sample bottles using a "Sample Bottle and Preservation Request" form.

Field blanks are not practical for all parameters and should not be attempted for the following sample containers: sediment, sludge, soil, tissue or matrices other than water, dissolved oxygen or flash point determinations. Field blanks are of maximum value when a chemical preservative is added which could be contaminated with the parameters to analyzed. Ideally, each batch of samples collected should have appropriate field blanks, especially where litigation is imminent. The preservative should be added to the sample in the field at the time other samples are set.

Proper interpretation of the values obtained from field blank analysis is difficult. Acceptable limits should be established based on the variability of actual field blanks and analytical precisian of each parameter. When a field blank value is found to be excessive for a parameter, the results for that parameter should ideally be discarded and the source of the problem located if possible. Any chemical preservatives under suspicion should be immediately recalled to the lab and replaced with a new lot. The preservative should then be checked by the laboratory using proper analytical techniques to verify that the preservative was contaminated. Results from sample batches with marginally unacceptable field blanks may be of some value depending on the intended use of results and the concentrations found. If results are used, they should be appropriately coded. Occasionally it is valid to subtract field blank values for sample results, but this practice should not be standard policy. Because of the inherent variability of an analytical result, abusive use of one value should be avoided. Also, because of the extreme sensitivity of some analytical method and variable impurities present, even in deionized-distilled water, positive values may be due to the water supplied for the field blanks.

The laboratory has had instances where the highest value for a batch of samples was the field blank. Sample bottles which do not receive chemical preservatives are still valid checks as field blanks to check on sample bottle suitability and handling procedures. Because these should be less of a problem, once proper documentation of the lack of a problem is made, the frequency can be limited to periodic checks.

Split Samples

If samples are to be analyzed by two or more different laboratories as check of analytical performance, it is imperative that each laboratory is analyzing the same sample to start with. A representative subsample of a homogenized sample should be submitted to each lab. It should be absolutely clear to all participants what parameters are to be analyzed and how they are to be reported. If there are only two participants, the results should be checked for overlapping confidence intervals based on expected precision of the two laboratories. It may be difficult to locate the source of any significant differences identified. Some of the most frequent causes of error are the use of an improper method, the improper use of a correct method, an inadequate quality control program or a poorly trained laboratory staff.

When more than two laboratories perform split sample analysis, it may be easier to spot poorly performing laboratories. Quite often, individual performance is measured against a median value or "true" expected value if available. Definite outliers should erroneously influence the results through common use of biased methods. Different studies may be require different methods of evaluation depending on individual circumstances.

Field Spikes

Field spikes of standards into samples or laboratory supplied distilled water are of major interest for special studies rather than routine use because of special precautions which should be taken. They are of value in determining the suitability of a sample container for certain parameters, the accuracy of methods and the applicability of holding times.

SECTION II

SELECTION OF SAMPLE BOTTLES, PRESERVATIVES AND MAXIMUM HOLDING TIMES

The laboratory will supply any sample containers which are to be used for samples to be analyzed by the ANALYTIC & BIOLOGICAL LABORATORIES, INC. or must approve the use of alternate bottles for collection. A variety of recommended sample containers are available with specific bottles or bags being recommended for various parameters groups because of: 1) the material(s) the container is constructed of; 2) physical properties of the parameter(s) to be analyzed; 3) sample volumes required for analyses; 4) special preservation requirements; and 5) the special needs of the laboratory unit performing parameter analyses. If there is some questions as to which sample container is required, consult the appropriate laboratory unit supervisor.

The chemical and physical preservation techniques to be used are available from laboratory unit supervisors. Preservation techniques are in accordance with EPA recommended procedures with occasional deviations due to particular laboratory situations requiring alternate preservation techniques. The protocol for alternate preservation techniques approval has been previously established by EPA, Region V and should be followed as necessary.

The maximum holding times recommended by the laboratory are generally the same as or slightly shorter than the approved EPA holding times. The holding time is time from sample collection until the sample is brought into a more stable state during the analysis process. It is not sufficient to merely receive the sample at the laboratory within the maximum holding time. Field personnel must keep in mind that the laboratory must have ample time to analyze the sample. The laboratory has the right and obligation not to analyze any sample which in their opinion may not be indicative of field conditions due to excessive holding time. Samples which have marginally exceed maximum holding times may be analyzed and appropriately coded at the discretion of the appropriate unit supervisor.

SAMPLE PARAMETER GROUP CODES

The following codes are used as a convenient reference so that field personnel can readily identify which sample container is necessary for any individual parameter. The parameter group codes are as follows:

LAB UNIT	PARAMETERS	CODE
Environmental Quality	Dissolved Oxygen	DO
	COD, TOC, Phenols	C/T/P
	Cyanide, Thiocyanate	CN
	Sulfide	S
	COD, Nutrients, Anions	ION
Organic Contaminants	Acid Extractables or Base-Neutrals Extract.	OEXT
	Purgeable Organics	PO
	O.C. Misc	OCM
	Oil & Grease	O&G
	Sediment, Sludge, Soil	OSSS
	Hazardous Waste	OHW
	Tissue	OTIS
Physical	Bacti	BAC
	Chlorophyll	CA
	Physical (residue, etc.)	PHYS
	Flash Point	FP

These codes should also be used by field personnel to facilitate identification and sorting of sample containers during the laboratory reception process.

USE OF THE SAMPLE BOTTLE AND PRESERVATION REQUEST

To facilitate the ordering of sample containers and preservatives, a "Sample Bottle and Preservation Request" form should be used. They should be filled out and received by the laboratory at least one week prior to the planned pickup time. If there remains insufficient time for proper notification, bottle orders should be prepared and phoned in to the proper designees in the Physical and Biological Lab Unit with as much advance notice as possible. Where more than one size bottle is identified, the responsible lab units should be consulted, or the following guidelines may be of value:

1) C/T/P - A 250 ml plastic bottle is sufficient if only chemical oxygen demand and total organic carbon or only phenolics are requested; a 500 ml bottle may be necessary for all three parameters (Note: Chlorinated sample for phenolics should be dechlorinated with ferrous ammonium sulfate and preserved separately from COD and TOC sample).

2) CN - A 500 ml plastic bottle is required if free cyanide is to be determined. Otherwise, a 250 ml container will be sufficient.

3) M-TOT - A 500 ml plastic bottle should be sufficient unless a) low detection limits are required, b) As, Se and/or Hg are requested in addition to other trace metals or c) a large number of metals (more than a dozen) are requested from each sample, in which case, a liter of sample may be necessary.

4) M-DIS - Same as above example (M-TOT)

5) M-SSS or M-TIS - Generally, a specimen bag is more suitable for tissue samples and a 250 ml wide-mouth glass bottle for sediment, sludge or soil for metals. The same sample may presently be shared by the Environmental Quality Unit.

6) PHYS - The number of residue analyses per sample is the main factor in determining the required size for physical bottle. If only pH, specific conductance, color and/or turbidity are required, 250 ml should be sufficient. If routine residues (filterable, non-filterable or total) are requested, a 500 ml bottle will suffice. Additional residue analyses (particularly settable residue) may require 1000 ml of sample.

There may be additional sample containers required for non-routine analysis not listed. Check with the laboratory if in doubt. It is generally better to make sure that the laboratory has sufficient sample in the proper container than to risk not receiving the desired analyses.

The chemical preservatives and dechlorinating agents are available from the laboratory either as a kit or as individual preservatives. Field personnel which routinely collect samples will find it more convenient to have a kit assigned to them and restock chemicals as needed or at least every six months. Personnel which do not frequently collect samples may find it more convenient to request preservatives with each survey or batch of samples and return the preservatives when samples are submitted to the laboratory. A preservative kit which is not frequently used should be carefully stored to prevent contamination of the chemicals. Most of the chemicals are stable and not prone to significant decay. Setting chemical preservatives blanks is imperative when a kit has not been used recently. Old kits must be returned to the lab for restocking.

LABORATORY RECEIPT OF SAMPLES

In the instance that your company finds it necessary to request emergency testing and analysis and have special samples you need to deliver to us, ANALYTIC & BIOLOGICAL LABORATORIES, INC. is generally able to receive samples from 8:15 AM until 5:00 PM Monday through Friday (with the exception of holidays). The lab may be able to receive samples at other times with prior notification and clearance. The sample receive entrance is at the front of the building. After admittance, the field personnel should set up samples from left to right in the order they will be recorded on the sample sheets. Each sample should be maintained in columns and the rows should be lined up by the parameter groups. The sample receiver then enters the lab log number, project code, case center number, priority and their initials on the sample blanks. Laboratory sample numbers are recorded on each of the proper blanks, the type of sample, the parameters to be tested for, the date the sample was taken, the date the sample was received , the company name, address, phone number and the initials of the receiver. Appropriate laboratory sample numbers are then noted on the sample containers. Field personnel should assist in wiping off wet bottles so the labels adhere properly. A copy of the sample receipt form is given to the field personnel for immediate review and future reference. Future laboratory identification will be based mainly on the sample number tag.

Lab unit supervisors or their representatives are then notified of the samples' existence. They then confirm that there is adequate sample to perform the requested analysis and that the samples are numbered and labeled correctly. If there is not enough sample available to complete the testing and allow for remaining sample to repeat the test if necessary, then it should be brought to the attention of the field personnel immediately so that additional sample can be collected and submitted as soon as possible.

LABORATORY SAMPLE HANDLING

Except for shared samples, each laboratory unit is exclusively responsible for maintaining the integrity of the samples it receives. Physical preservation must be sustained until the analysis is completed. Work assignments should be made on the bases of priority assignments, holding time, any existing backlog, present analytical capability, batch size efficiency and other factors. If individual analysts are unable to complete assigned work within the time allotted, the appropriate unit supervisor or lead worker should decide the order of completion or reassign other analysts to assist.

Each analyst is responsible for recording all pertinent information related to analyses they are performing in a concise, permanent manner which could be easily interpreted by other analysts familiar with the techniques involved. Bound notebooks with numbered pages are recommended over loose sheet because : 1) results remain in a chronological sequence in a bound notebook, 2) loose sheets are more easily lost, 3) loose sheets may not be acceptable as court evidence because they could be changed, and 4) bound data files are easier to maintain for long-term storage. All permanent work should be recorded in ink. Any corrections or changes to values should be done by drawing a single line through the old value such that it could still be read and then writing the new value. An explanation to any changes should also be included if necessary to clarify results. When performing analyses, any non-routine behavior by samples should be noted and explained if possible. Potential interferences should be monitored and removed where possible. Unexplained problems should be brought to the attention of the appropriate lead worker or unit supervisor for recommendations as to further actions. Calculations should be brought to the attention of the appropriate lead worker or unit supervisor for recommendations as to further actions. Calculations should be performed with attention to the rules for significant figures and rounding of numbers. Complex calculations should be performed with the aid of a programmable calculator to minimize analysts errors. Each analyst should also review their final results as much as possible through the proper quality control audits,
comparison with related samples and check for correlation with related parameters. Any bench notebooks or sheets should be kept for three years or longer if litigation is pending.

The unit supervisor's review before reporting laboratory data should include any of the following applicable steps: 1) review of quality control audits for suspicious data, 2) check for proper correlation of related parameters (which may require review of results from another lab unit), 3) analysis for reasonable trends within batches of related samples, or 4) comparison with previous results from the same sampling location. Questionable results should be investigated as thoroughly as possible.

The data supplied by the analysts may require rounding to the proper significant, coding with remark codes or conversion to the proper reporting units.

It is generally desirable to report two or three significant figures wherever practical when reporting laboratory data. Only one significant figure will probably be achievable near the analytical detection limit of a parameter. The confidence level or reliability of a result is dependent upon the variability of the method at the concentration level of measurement. If the standard deviation for a value is known, the confidence interval can be estimated for a desired confident level by:

confident level = $\bar{X}$ +/- z - x

where z is the normal deviate. If a value of 16.5 is obtained with a standard deviation (σ) of 0.3, various confidence intervals would be calculated as:

Confidence Level	Normal Deviate (z)	Confidence Interval
.68	1.00	16.2 to 16.8
.80	1.28	16.1 to 16.9
.90	1.64	16.0 to 17.0
.95	1.96	15.9 to 17.1
.98	2.33	15.8 to 17.2
.99	2.57	15.7 to 17.3
.998	3.08	15.6 to 17.4

A 95 % confidence interval is often used, meaning that when a value of 16.5 is reported for a method with a standard deviation of 0.3, the data user can be 95 % confident that the values lies between 15.9 and 17.1. On the average, the values will be outside this interval one out of twenty times.

When sample handling or laboratory operating conditions are less than optimum, the unit supervisor must decide whether results should be sent at all or with remarks to qualify potentially reliable data. If data is known to be unreliable, or highly suspected as such, no value is reported. Because environmental samples are ordinarily grossly heterogeneous, a large number must be analyzed to obtain meaningful data. The number of individual samples that need to be analyzed will depend on the kind of information required by the plan model. If an average compositional value is required, a large number of randomly selected samples may need to be obtained, combined and blended to achieve a reasonably homogeneous composite of which subsamples may be analyzed. If composition profiles or the variability of the sample population is desired, many samples may need to be individually measured in replicate.

A statistical approach to sampling is possible when the standard deviation of the individual samples is known in advance or be reasonably estimated. An example, described by Walpole and Myers (8), uses the expression where N = number of samples, Z = constant

$$N = (Z - n/E)^2$$

(standard - normal) ➢ n = standard deviation of individuals, and E = tolerable error in estimate of mean for characteristic measured.

For illustration, assume that the samples to be measured are expected to have a mean concentration of approximately 0.1 ppm and that the tolerable error in the stated value of the mean is at the 95 % confidence level (Z = 1.96) does not exceed 20 % (0.02 ppm). A further assumption is made that the measurement error is small in comparison with the measured values and can be neglected in the calculation. With the above values, the number of samples required will be

$$N = (1.96 \times 0.05) / 02^2 = 24$$

One could either analyze 24 individual samples or combine them and analyze a homogenized composite. However, the composite would not give any information on the variability of the individual samples (valuable for checking the sampling strategy used) not prove that a sufficiently homogeneous sample had been produced. The latter would require the analysis of a sufficient number of subsamples (seven is suggested).

Unfortunately, environmental trace analysis is often done where the standard deviation of the individual samples is not known in advance and where the measurement error cannot be predicted nor can it be assumed to be negligible. In this case, the measured values can be used to calculate an overall standard deviation, σ_o, which is related to the standard deviation of measurement, σ_n, and the standard deviation of individuals, σ_m, by the expression

$$\sigma_o^2 = \sigma_m^2 + \sigma_n^2$$

An estimate of σ_m can be obtained by a pooling process, using the differences in the measured values of duplicate homogenized samples. Then the standard deviation of the individual samples, σ_n, can be calculate. Unless such calculations are based on large numbers of measurements (at least seven) the standard deviation(s) may be significantly underestimated. In this case, the appropriate value of the Student's t test should be used and t values should be substituted for Z in equation 1 and similar expressions.

Equation 1 may also be used to estimate the number of replicate measurements, n, required on a homogeneous sample to achieve a mean value within a given confidence interval, E. In this case, o represents the standard deviation of measurement. The following transposition of the equation may be used to calculate

$$E = Z - m/n^{1/2}$$

The confidence interval, $\bar{x} = E$, for the mean of n measurement. When the data needed to calculate the minimum number of samples (N) are not available at the time of sampling, empirical approaches may need to be followed. In this case, the N-N-N rule is recommended as a helpful guideline, this means that equal numbers (N) of field samples, field blanks and spiked blanks are to be analyzed along with the calibrating standards and controls. The rule was first used in U.S.D.A. pesticide residue studies as the 10-10-10 rule. This meant that a residue study required analysis of a minimum of 20 samples, 10 field blanks and 10 spiked field blanks. A 7-7-7 rule is currently used by the U.S. Environmental Protection Agency in the analysis of water and waste water samples. Field blanks (sometimes call control studies in agricultural investigations) of environmental samples that are believed to contain the analyte at levels below the limit of detection of the analytical method. In certain circumstances a simulated or synthetic field blank is the only alternative.

CHAIN OF CUSTODY

SECTION III

SAMPLE RECORDING AND PROCESSING -- CHAIN OF CUSTODY

All samples received in the laboratory are recorded on a two page work sheet. The original work sheet is maintained in the laboratory office for sample control and the duplicate stays with the sample until test completion.

At the office level, all samples are assigned a laboratory number and are entered into our in-house storage via floppy-disc, instant sample recall, and documentation of sample as to date, laboratory findings, and other pertinent data.

Upon receipt into the Chemistry Laboratory, the samples are recorded in a laboratory bound ledger along with all data concerning the sample. Laboratory data obtained from calculations in the ledger are transferred to the duplicate work sheet which is forwarded to the laboratory office upon completion. The samples are then recorded as being performed and typewritten reports are made from the laboratory work sheets. A complete analytical report will be furnished for each sample via computer with 48 hours upon test completion; thus allowing receipt of the original by the central office and/or the district originating the sample, within the allotted time. Upon competing, the analyst performing the test initials the laboratory copy of the finished report, indicating that the typist has accurately transferred all information from the laboratory work sheet. This is maintained in the laboratory files in conjunction with the duplicate work sheet.

Any discrepancy in the final reporting may be traced through the copy of the final repot, the laboratory work sheet, and the laboratory ledger containing all calculations. The logbook-ledger must be protected and kept in a safe place.

Chain of Custody

To establish the documentation necessary to trace sample possession from the time of collection, a chain of custody record must be filled out and accompany every sample. This record becomes especially important when the sample is to be introduced as evidence in court litigation. An example of a chain of custody record is illustrated.

The record must be contain the following minimum information:

Collector's sample number

Signature of collector

Date and time of collection

Place and address of collection

Waste type

Signatures of persons involved in chain of possession

Inclusive dates of possession

ANALYTIC & BIOLOGICAL LABORATORIES, INC.
24350 INDOPLEX CIRCLE, FARMINGTON HILLS, MI 48331
(313) 477-6666 FAX: (313) 477-4604

Collector's Sample No. _____

CHAIN OF CUSTODY RECORD

Location of Sampling: _____

Sample Identification: _____

Shipper Name: _____

Shipper Address: _____
street city state zip

Collector's Name: _____ Telephone: _____

Date Sampled: _____ Time Sampled: _____

Type of Process Producing Waste _____

Field Information:

_____

_____

_____

Sample Receiver:

1. _____
Name and address of organization receiving sample

2. _____

3. _____

Chain of Possession:

1. _____
signature title inclusive dates

2. _____
signature title inclusive dates

3. _____
signature title inclusive dates

DATE 03-30-89

PRECISION AND ACCURACY CONTROL DATA

#	PARAMETER	RT TIME	SPIKE VALUE	RECOVERED VALUE	% RECOV
1	Methanol	1.71	10,000	10,910	109.1
2	Methylene Chlo	5.85	10,000	10,320	103.2
3	Acetone	7.66	2,000	2,088	104.4
4	Trichloro Fluo	8.20	2,000	2,108	105.4
5	Ethyl Ether	9.90	2,000	2,064	103.2
6	Carbon Tetrach	11.78	2,000	2,018	100.9
7	Ethyl Acetate	12.86	2,000	2,014	100.7
8	Butyl Alcohol	13.70	2,000	2,082	104.1
9	Pyridine	15.64	2,000	1,992	99.6
10	Trichloroethyl	16.44	2,000	2,090	104.5
11	Cyclohexanone	20.90	2,000	2,194	109.7
12	Methyl Isobuty	21.03	2,000	2,194	109.7
13	Tetrachloroeth	22.91	2,000	2,244	112.2
14	Toluene	24.06	2,000	2,034	101.7
15	Chlorobenzene	25.40	2,000	1,072	103.6
16	Ethyl Benzene	28.01	2,000	1,970	98.5
17	Xylene	33.65	2,000	2,102	105.1

SAMPLE ID : _____

COMPANY: _____

LAB ID #: _____

DATE 03-30-89

PRECISION AND ACCURACY CONTROL DATA

PARAMETER	SPIKE VALUE	RECOVERED VALUE	% RECOVERY
Arsenic	20.0	19.69	98.1
Barium	10.0	9.912	99.1
Cadmium	10.0	10.17	101.8
Copper	10.0	9.634	96.34
Chromium	10.0	10.43	104.3
Lead	10.0	10.23	102.3
Mercury	20.0	19.82	99.1
Selenium	20.00	19.88	99.4
Silver	10.0	20.37	101.9
Zinc	10.0	10.0	101.9

SAMPLE ID: _____

COMPANY: _____

LAB ID #: _____

PRECISION & ACCURACY

CONTROL DATA

PARAMETER: Copper

UNITS: mg/l

SPIKE: 10 mg/l

DATE	LAB I.D.	DUP. 1	DUP. 2	RANGE	AVG.	SPIKE VALUE	DIFF.	% REC
5-5	29459	.343	.346	.003	.345	10.99	10.645	106.4
5-10	24653	.105	.118	.013	.112	9.876	9.764	97.64
5-15	27858	.064	.059	.005	.062	10.38	10.318	103.2
5-17	26322	.046	.083	.008	.042	10.17	10.128	101.3
5-23	28569	.181	.189	.008	.185	10.49	10.305	103.0
5-24	28560	.187	.178	.009	.183	10.38	10.197	101.2
5-30	29468	.013	.009	.004	.011	9.71	9.699	96.99
5-31	29581	.035	.036	.001	.036	10.23	10.194	101.9
6-5	29763	.081	.088	.007	.085	10.24	10.155	101.5
6-7	29799	<.005	<.005	0	<.005	9.63	9.63	96.30
6-13	29805	.028	.031	.003	.030	9.61	9.58	95.80
6-15	29837	.033	.037	.004	.035	10.93	9.895	98.95

PRECISION & ACCURACY

CONTROL DATA

PARAMETER: Alkalinity

UNITS: mg/l

SPIKE: 200 mg/l .

DATE	LAB I.D.	DUP. 1	DUP. 2	RANGE	AVG.	SPIKE VALUE	DIFF.	% REC
6-1	29459	59	61	2	60	262	202	101
6-4	24653	19	21	2	20	224	204	102
6-5	27858	57	61	4	59	260	201	100.5
6-7	26322	40	44	4	42	245	203	101.5
6-8	28569	16	24	8	20	220	200	100
6-12	28560	60	60	0	60	258	198	99
6-13	29468	49	51	2	50	250	200	100
6-14	29581	60	64	4	62	264	202	101
6-15	29763	39	41	2	40	240	200	100
6-26	29799	43	41	2	42	243	203	101.5

MONTH June

YEAR 1989

CHEMICAL PARAMETER: Arsenic

UNITS: mg/l

STANDARD VALUE: 100 mg/l

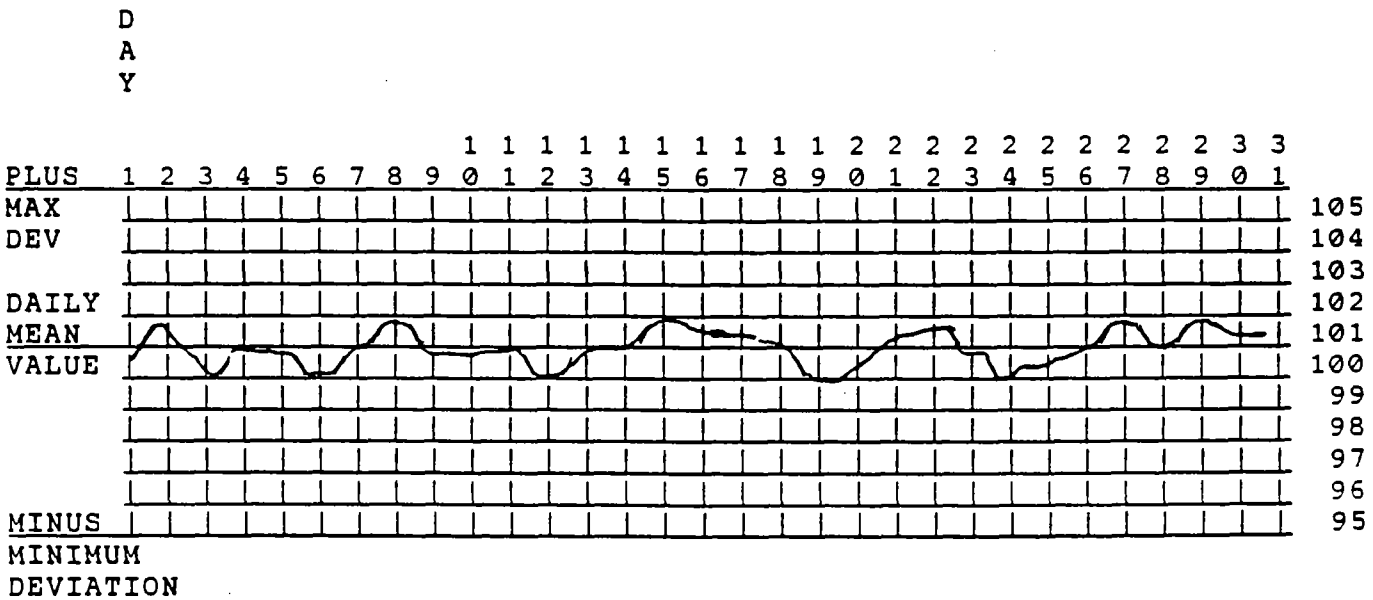


FIGURE 1

PRECISION CONTROL CHART

SAMPLE NUMBER VERSUS RANGE

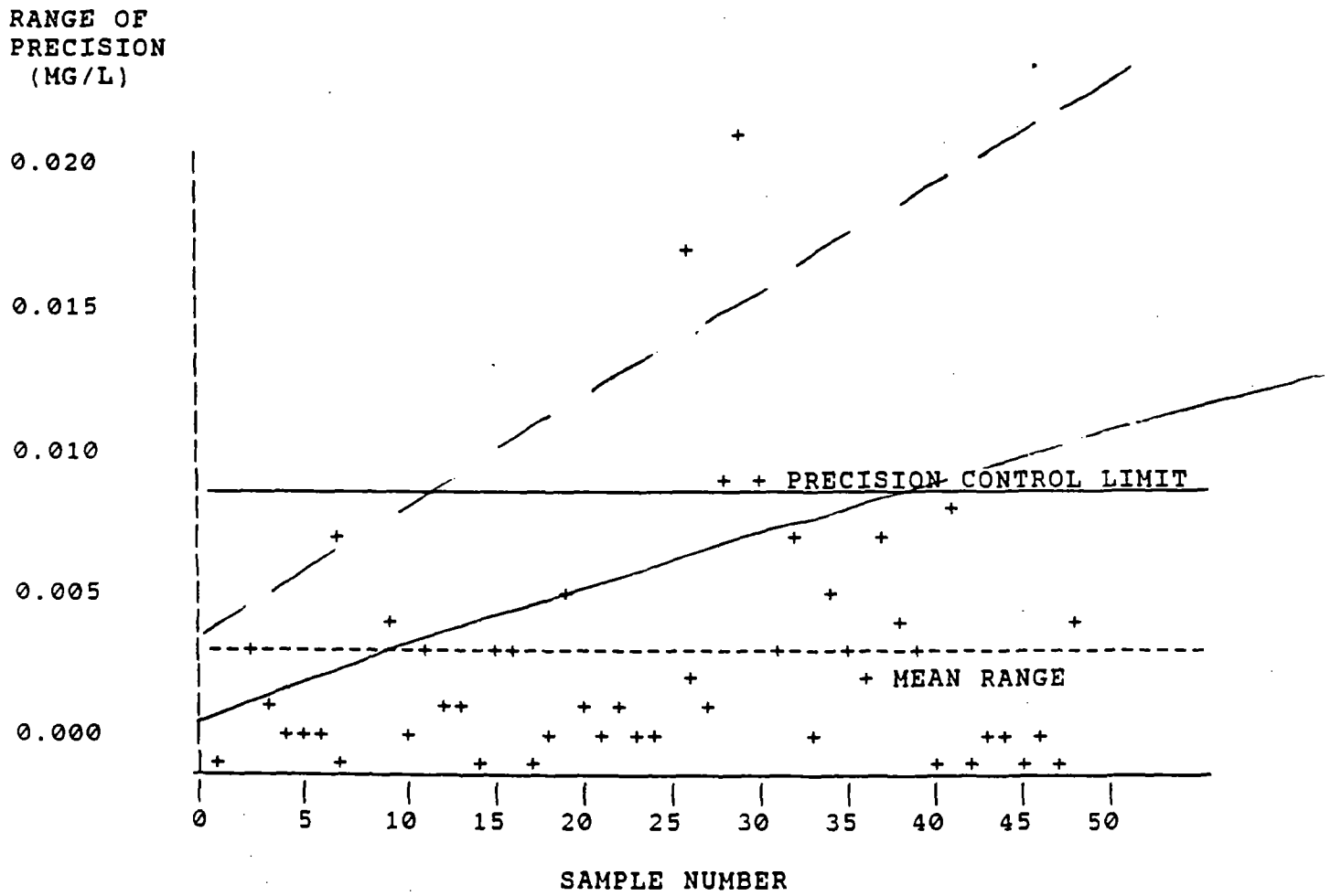


FIGURE 2

PRECISION CONTROL CHART

MEAN SAMPLE VALUE VERSUS RANGE

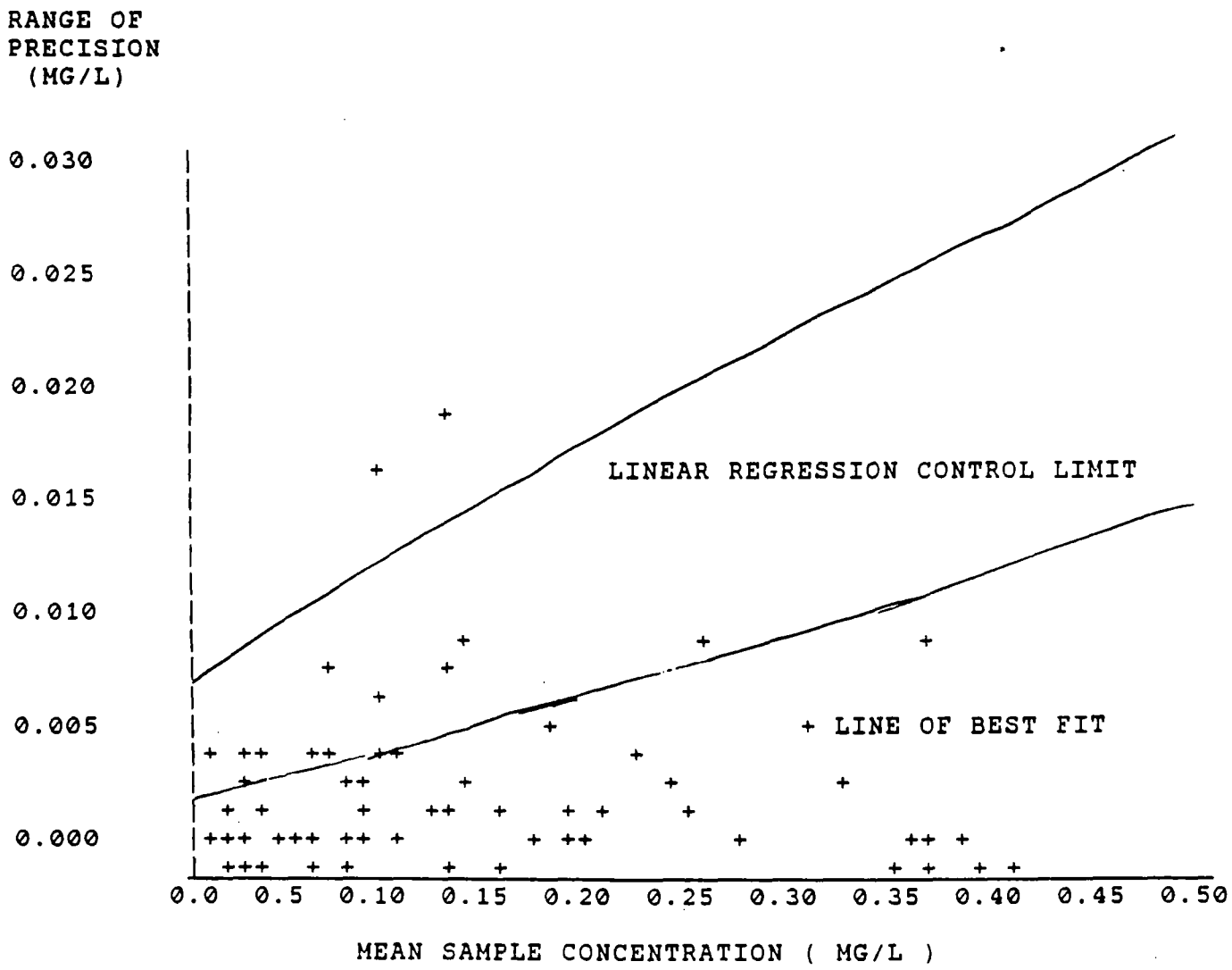


FIGURE 3

PRECISION CONTROL CHART

MEAN SAMPLE VALUE VERSUS RANGE

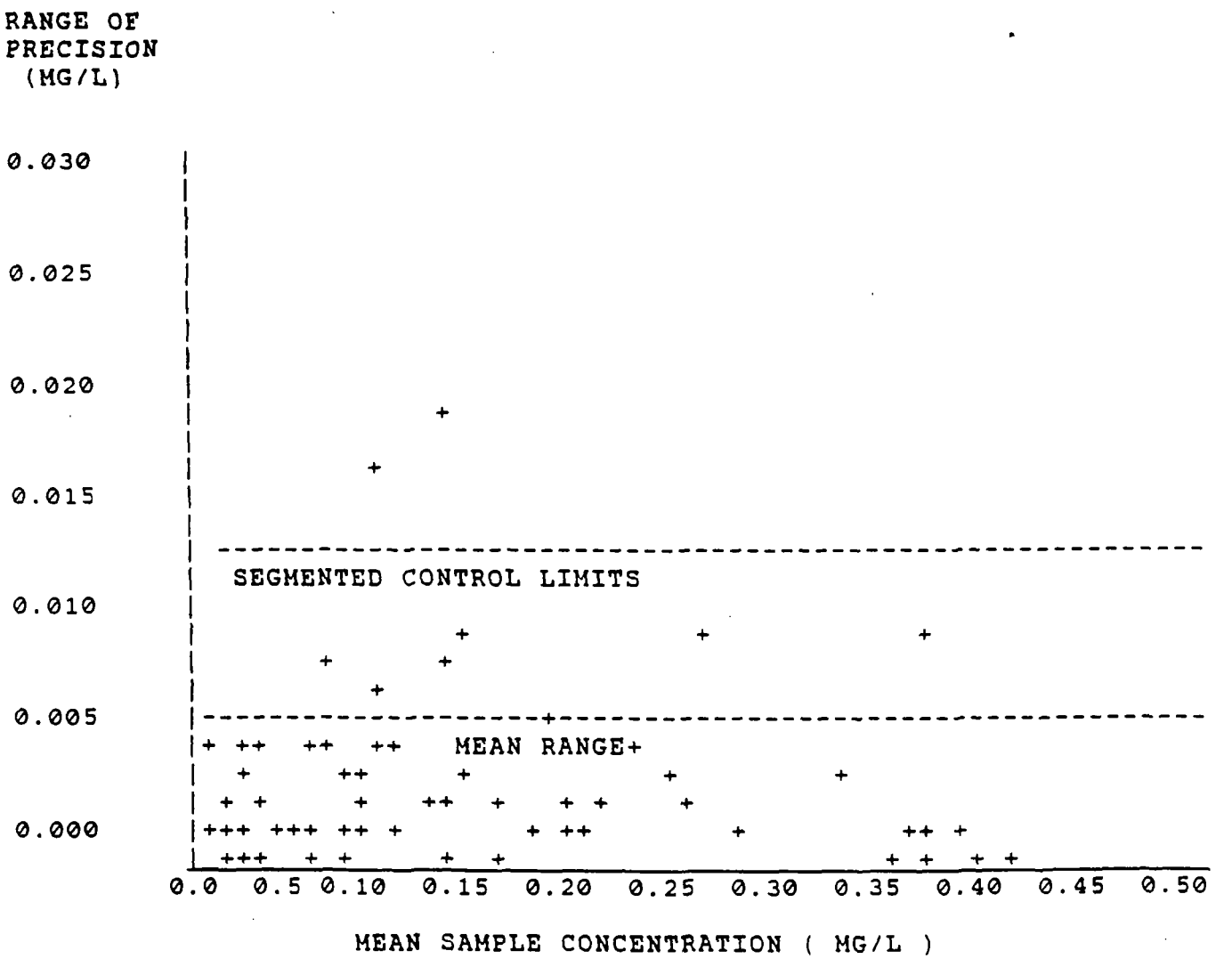


FIGURE 4

ACCURACY CONTROL CHART

SAMPLE NUMBER VERSUS % RECOVERY